DEPARTMENT OF THE INTERIOR.

REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY

OF

THE TERRITORIES.

F. V. HAYDEN,
UNITED STATES GEOLOGIST-IN-CHARGE.

VOLUME VIII.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1883.

NOTE.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
November 1, 1883.

On the 27th of September, 1882, at the request of Dr. F. V. Hayden, the completion of the publications of the United States Geological and Geographical Survey of the Territories, formerly under his charge, was committed to the charge of the Director of the Geological Survey by the following order from the honorable the Secretary of the Interior:

DEPARTMENT OF THE INTERIOR,
Washington, September 27, 1882.

Maj. J. W. POWELL,
Director U. S. Geological Survey, City:

SIR: The letter of Prof. F. V. Hayden, dated June 27, bearing your indorsement of July 20, relating to the unpublished reports of the survey formerly under his charge, is herewith returned.

You will please take charge of the publications referred to in the same, in accordance with the suggestions made by Professor Hayden.

It is the desire of this office that these volumes shall be completed and published as early as practicable.

Very respectfully,

H. M. TELLER,
Secretary.

Of the publications thus placed in charge of the Director of the Survey, the accompanying volume is the second to be issued. The first was entitled "The Vertebrata of the Tertiary Formations of the West, by Edward D. Cope." On the 12th day of October, 1882, the manuscript of the present volume was received at the office of the Geological Survey, and through the hearty co-operation of Professor Lesquereux, the work has been pushed to rapid completion. The volume is an important contribution to the ancient botany of North America, and will be heartily welcomed by paleontologists.

J. W. Powell

Director.

LETTER TO THE SECRETARY.

WASHINGTON, *November 1, 1883.*

SIR: I have the honor to transmit, for your approval, the eighth volume of the final reports of the United States Geological and Geographical Survey of the Territories, prepared by the eminent paleontologist, Prof. Leo Lesquereux.

A brief synopsis of the contents of the volume may be given as follows:

In the first part—the Cretaceous Flora—are described a large number of new species, some representing rare and very remarkable types, all of which are figured on the first seventeen plates. Besides the description of the species, there are some general remarks on the geology of the Dakota group, and on the character of the plants in regard to climate and their affinities with plants of succeeding geological periods. A table of distribution is added, enumerating all the species known up to the present time, pointing out the relations of the plants of Europe and various parts of North America with those of the Dakota group in Nebraska, Kansas, and Colorado. The number of species enumerated in this table is 443, of which 200 are from the Dakota group.

The second part contains a revision of the plants of the Laramie group. The introduction considers the relations of these plants to those of Europe, for the purpose of fixing the age of the formation. Then follows a description of a few new species from very fine specimens on three plates, and a table of distribution including only the species of the Laramie group, which in the seventh volume of the series were mixed with those of the other stages of the Tertiary and were not grouped clearly enough for the proper appreciation of the general characters of the flora.

Up to the present time the author has been unable to find a single species that he could identify with any from the Dakota group. He has now in his possession very large collections of plants from this group, which have not been reported upon, collected in Colorado and Wyoming; yet after a careful examination he fails to find any form even related to those of the Dakota group.

The third part reviews the flora of the White and Green River regions, which he separates into two groups. The plants of Green River and Alkali

Stations and Randolph County, Utah, are most of them different from those of Florissant, Mouth of White River, and Elko. These plants are represented by twenty-one plates, and their relation is indicated with the flora of the Gypses of Aix in France, which is generally regarded as lowest Miocene or Oligocene. The table of distribution of these plants includes, in America, those of Florissant, Elko, Green River Station, Alkali Station, Sage Creek, and Barrell Springs as compared with the Miocene of Greenland, Alaska, the Oligocene of France and Germany, and the Miocene of Europe.

The fourth part relates to Miocene plants described from specimens obtained from the Bad Lands, California, and Oregon, and from Alaska, and they occupy fifteen plates. There is also a table of distribution that indicates the relations of these species of Alaska, Carbon, Washakie, the Bad Lands, Oregon, California, and Fort Union with the Arctic Miocene, Greenland, Spitzbergen, and those of Europe. This eighth volume forms a kind of supplement to the two preceding volumes, inasmuch as in it are figured and enumerated all the plants which have been found since their publication, in the formations of the Mesozoic and Cenozoic periods of North America, and therefore forms a broad basis in vegetable paleontology for the direction of future researches and the classification and determination of the fossil flora of the Continent. The three volumes of this series, on vegetable paleontology, form a grand monument to the industry and fame of the author.

I take pleasure in acknowledging my obligations to the Director of the U. S. Geological Survey, who has with great kindness superintended the printing of this Report.

The plates were engraved by the well-known firm of Thomas Sinclair & Son, of Philadelphia, and are fine examples of their work.

I have the honor to remain, with great respect, your obedient servant,

F. V. HAYDEN,
United States Geologist.

To the Honorable the SECRETARY OF THE INTERIOR.

UNITED STATES GEOLOGICAL SURVEY OF THE TERRITORIES.

CONTRIBUTIONS

TO

THE FOSSIL FLORA

OF THE

WESTERN TERRITORIES.

PART III.

THE CRETACEOUS AND TERTIARY FLORAS.

By LEO LESQUEREUX.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1883.

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LETTER OF TRANSMITTAL.

COLUMBUS, OHIO, *September 30, 1882.*

Dr. F. V. HAYDEN, *Philadelphia.*

DEAR SIR: I send herewith the manuscript of the eighth volume of the Reports of the United States Geological Survey of the Territories, made under your direction. Besides a short introduction, this volume contains:

1st. A review of the Cretaceous Flora of the Dakota Group, or of what has been published in volume VI, with descriptions of a large number of new and remarkably interesting species illustrated by 17 plates.

2d. Some remarks on the Flora of the Laramie Group, which I consider as Eocene, with descriptions of a few new species, illustrated by 3 plates.

3d. The more valuable part of the volume, viz: the descriptions of the plants of the Oligocene, a flora of which little was known before, and which is now richly represented by a large number of specimens, especially from Florissant, Colorado. This Flora will be quite as well received by paleontologists as has been the Cretaceous Flora of volume VI. It is illustrated by 24½ plates, which are all very finely made.

4th. Half of one plate serves for illustrations of a few plants from the oldest Pliocene, or upper Miocene of California.

5th. Descriptions with figures of Miocene plants of the Bad Lands, with 5 plates. The plants, clearly of Miocene type, are very interesting from their relation to species of the Arctic Flora.

6th. Descriptions of species of Miocene plants of California and Oregon from specimens pertaining to the State Museum of Oakland, California. They are illustrated by 10 plates, the whole number of the plates being 60.

7th. A short account and description of new species found in a collection of fossil plants made in Alaska by W. H. Dall, of the United States

Coast Survey, for the Smithsonian Institution. The specimens were sent to me for determination, and I was allowed to give in volume VIII a short description of the new species added to the Alaskan Flora already partly known by the works of Heer. These new species have been figured in the Proceedings of the National Museum, vol. v, pl. vi–x.

It is not unnecessary to remark that all the plants described in volume VIII are considered in separate groups according to their relation to the age of the formation which they determine. Comparisons are established with the European Floras by tables of distribution, etc.

I truly believe that this volume will prove to be a very valuable contribution, not merely to the paleontology but also to the geology of this country.

Very truly and respectfully yours,

LEO LESQUEREUX.

CRETACEOUS AND TERTIARY FLORA.

By Leo Lesquereux.

INTRODUCTION.

The present volume contains:

1st. The materials referable to the Cretaceous Flora.

The species recognized from specimens received since the publication of the Annual Report of Dr. F. V. Hayden, 1874, are of course described here, but it has been found advisable to add to them and to consider again part of what has been published in that report as a Review of the Cretaceous Flora of North America; mentioning also the species described by Professor Heer and Dr. Newberry from specimens obtained from the Dakota Group.

It is well known that the plants of the Cretaceous epoch, at least those of a higher class, the Dycotyledons, have been barely discovered and described in Europe, while the profusion of these vegetables in the Dakota Group constitutes an original illustration of a peculiar vegetation which, for reasons explained hereafter, will be of great significance in the future. From this consideration the exposition, in the same work, of all that is known to this time of the North American Cretaceous Flora is greatly to the advantage of vegetable paleontology both in this country and in Europe.

2d. A description of a few species of plants of the Laramie Group, which I persist in considering as Eocene.

These species, added in this volume to the list of the plants already described from the same formation, were all obtained at Golden, Colorado, from the locality where most of those published formerly were found by myself. One, *Oreodoxites plicatus*, a fine Palm, represented by a number of well-preserved though more or less fragmentary leaves, is of a peculiar type,

and finds its affinity only in *Ludoviopsis geonomæfolia*, Sap., of the Eocene of Sézanne. A second, *Sterculia modesta*, Sap., also of Sézanne, is represented by a beautifully preserved specimen whose identity has been recognized by the author. A third, *Aralia pungens*, is remarkable for its very close relation, perhaps identity, to four species described by Massalongo as *Sylphidium* from the Eocene of Italy. And still a fourth, *Zizyphus Beckwithii*, is evidently allied to *Z. Harcourtii* of Sézanne. These, on seven species only, added to the flora of the Laramie Group, tend to confirm the conclusions which I have admitted on the age of the flora of the great Lignitic, or Laramie, Group.

3d. A large number of species described from what I called in Volume VII the Green River Group No. 4, which I considered as probably Miocene.

When that volume was published this flora was known only by a very few species. Since that time a large number of specimens have been procured from the same formation, especially at Florissant, Colorado. The species which they represent are very interesting as indicative of a geological period older than the Miocene, or preceding in age the Carbon and Alaska floras.

4th. A new contribution to the Miocene Flora from specimens procured from various localities of the Bad Lands of California and Oregon, with mention of new species recently obtained from Alaska, and a note upon a few specimens from the Chalk Bluff of California, a Pliocene formation.

I.—THE FLORA OF THE DAKOTA GROUP.

GENERAL REMARKS.

All that refers to the geology of the Cretaceous Dakota Group—its immediate superposition upon rocks of Permian age; its relation to the strata overlying it in an uninterrupted series of marine deposits up to the base of the Tertiary measures; its thickness, the superficial expanse of its area—has been recorded in the general remarks of Volume VI of these reports. Since that time very little has been added to what was known and published on the subject.

One fact only should be mentioned now. It is the discovery of numerous specimens of Cretaceous plants at the base of the Rocky Mountains in

Colorado. The plants, by the identity of a number of them and the close affinity of character of some others with species of the Dakota Group, have positively confirmed the supposition that this formation, passing westward in Kansas under the Tertiary measures, is prolonged under them and continues to the Rocky Mountains.

Already, in 1873, Dr. A. C. Peale had procured from Colorado fragments of poorly preserved leaves which had been recognized as identical with *Proteoides acuta*, Heer, a species commonly found in the Dakota Group of Kansas and Nebraska. From this, Nos. 14–16 of the section of South Platte River[1] had been then considered by Dr. Hayden as referable to a Cretaceous formation. More recently, Passed Assistant Engineer H. C. Beckwith, United States Navy, and Rev. Arthur Lakes, have got, near Morrison, a few miles west of Denver, numerous specimens of some of the more predominant species of the Dakota Group—*Sassafras* (*Araliopsis*) *cretaceum*, *Magnolia Capellini*, *Aralia*, *Salix proteæfolia*, etc., with some others, which though new are related species which tend to identify the Cretaceous formation at the base of the Rocky Mountains with that of Kansas. Admitting, therefore, the prolongation of the Dakota Group under the Tertiary measures to the base of the mountains, the width of the area covered by this formation should be estimated from east to west at 450 to 500 miles.

Perhaps, also, I should omit here any remarks on the flora of the North American Cretaceous as represented by the plants of the Dakota Group, having already, in Volume VI of the United States Geological Survey of the Territories, by Dr. F. V. Hayden, considered the general character of this flora and its relation to plants living at our time, or to analogous or identical species observed in the formations succeeding that of the Cretaceous. But the materials which I had then for consideration were few and local; they have since been greatly increased, and also new points for comparison have been furnished to phytopaleontologists by the works of Heer on the recently discovered Cretaceous plants of Greenland. From this, some of the conclusions formerly admitted have been more or less modified, while others have received a higher degree of precision

[1] Dr. F. V. HAYDEN, *Annual Report*, 1873, pp. 195, 196.

if not of actuality. It is thus advisable to look again over what is known to the present time of the characters of the North American Cretaceous flora and to record the deductions legitimately derived from that knowledge. This kind of work is a necessity for the present, as it will be also for the future, not only because what is known now is, probably at least, a mere fraction of the elements constituting the North American Cretaceous flora, but because the determinations of the plants are still and must be for a long time to come unreliable to a certain degree.

The plants of the Dakota Group, as known mostly by detached leaves, are striking from the beauty, the elegance, the variety of their forms, and from their size. In all this they are fully comparable to those of any geological epoch as well as to those of our time. From entirely developed leaves, less than one inch in size, they show all the gradations of size to one foot, even to a foot and a half in diameter. The multiplicity of forms recognized for a single species is quite as marked as it might be upon any tree of our forests; and to show the admirable elegance of their forms it suffices to say that, at first sight, they forcibly recall those of the most admired species of our time—the Tulip-tree, the Magnolia, the Sassafras, the Sweet-gum, the Plane-tree, the Beech, the Aralia, etc. The leaves of *Protophyllum Sternbergii* have the size and the aspect of those of the Catalpa, one of our finest ornamental trees. Those of *Menispermites obtusilobus*, of *Protospermum quadratum*, represent in the same manner some of the rarest shrubs, *Menispermum*, *Ferdinandia*, etc., carefully raised in conservatories for the graceful forms of their leaves or the richness of their vegetation. It is, indeed, the first impression received from the beauty of forms of the leaves of the North American Cretaceous, and the evident likeness of their *facies* to that of the finest vegetable types of our time, as we see them around us, which strikes the paleontologist, and may lead him into error in forcing upon the mind the belief of a typical identity where possibly there may be a mere likeness of outlines, a casual similarity of forms in the leaves. For, really, when we enter into a more detailed analysis of these Cretaceous leaves, we are by and by forcibly impressed by the strangeness of the characters of some of them, which seem at variance with any of those recognized anywhere in the floras of our time, and unobserved also in those of the geological intermediate periods. Not less surprised are we to see united in

a single leaf, or species, characters which are now generally found separated in far distant families of plants. The leaves of *Eremophyllum*, so striking by the peculiar appendages of their borders; those of *Anomophyllum*, referable to *Platanus* by one-half, to *Quercus* by the other; those of *Platanus obtusiloba*, half *Acer*, etc., are of this kind.

On another side, the characters of some of the Cretaceous species are sometimes of such a transient or indefinite order that it is scarcely possible to take hold of them and to describe them with any degree of reliance. At first sight they appear very distinct, but, in comparing a number of specimens, the differences dwindle by unmistakable transitions and disappear. In other leaves, on the contrary, visibly identical by their outlines, the nervation is so different that they are forcibly separated and referred to far distant generic divisions. Hence this flora does not leave any satisfaction, any rest, to the mind. Even the most clearly defined types become doubtful in regard to their integrity when we see others, which, at first, were recognized as positively fixed, manifesting instability and pointing to diversity of relation by the discovery of new specimens. The leaves considered first as *Sassafras*, for example, seemed evidently referable to this genus; but when leaves of the same type were found with dentate borders, though bearing, besides, all the characters of a genus which belongs to the *Laurineæ*, a family where, as yet, no representative has been found with dentate borders of leaves; when others were obtained with subdivisions of the lower lobes in two or three, thus showing the palmate shape of *Aralia* leaves, the confidence in the value of the characters at first recognized had to be abandoned.

The first exposition of the Dakota Group flora shows four species of Ferns, six species of Conifers, and one of *Cycadeæ* only. To this small number we have added in this volume one species of *Gleichenia*, six species of Conifers, and five of *Cycadeæ*. The specific values of some of the vegetable remains referable to the Conifers is, however, doubtful, especially for those which are represented by cones only. *Abietites Ernestinæ*, *Sequoia formosa*, *Sequoia Reichenbachi*, and the fragments described as *Inolepis* are of this kind; all, however, though their specific or generic relation may be uncertain, are evidently representatives of some species of

Conifer. The fragments referable to this group are difficult of determination, for the organs represented upon the coarse shale or hard ferruginous sandstone of the formation merely expose some traces of their more prominent outlines, originally printed upon the soft embedding matter. We do not find, therefore, any flattened cones with the scales, nor any flattened branches with leaves, but impressions only, more or less deeply carved into the stone, the cones even passing vertically or obliquely through the shales and showing the space originally occupied, as a mere cylindrical hollow, around which the forms of the scales are more or less clearly molded. The numerous leaves of *Pinus* spread upon the surface have dug in the same way, and by their hard substance, narrow linear channels, representing the back of these leaves, with an indistinct midrib; and branchlets of *Sequoia* also are seen as longitudinal grooves, bearing on both sides the same impressed form of their leaves. This cannot be considered a very distinct representation of characters, the minute details desirable for an exact determination being more or less obsolete.

Among the specimens recently examined, a second fragment has been found referable to *Phyllocladus*.[1] The presence of this genus in the Cretaceous flora is thus sufficiently ascertained. We may, therefore, record as recognized in the flora of the Dakota Group, for the Ferns, the genera *Lygodium*, *Sphenopteris*, *Hymenophyllum*, and *Gleichenia*, the first three by each one species, the last by two; in the *Cycadeæ*, *Podozamites* by six species, and in the Conifers, *Sequoia* by three species, *Pinus* by one, *Phillocladus* by one, *Torreya* and *Thuites* each by one, leaving out as of uncertain generic relation with the cones mentioned above, *Glyptostrobus* (?) *gracillimus*, which is perhaps identifiable with *Sequoia condita*, or with *Frenelites*, and *Geinitzia* (?), known merely by the impressions of some detached scales. To this should be added *Araucaria* from a species described in "Extinct Floras of North America" by Dr. Newberry, from Nebraska specimens.

The first dicotyledonous leaves described in the "Cret. Fl.," under the name of *Liquidambar integrifolium*, have been considered by some

[1] Since this was written, Heer, in part 2d of Vol. VI of the "Arctic Flora," has described this species under the name of *Thinfeldia Lesquereuxiana*, as a plant of uncertain relation.

authors as uncertain in regard to their generic relation merely on account of their entire borders. The form of the leaves, however, especially as figured (pl. xiv, fig. 3), with the lobes slightly enlarged above the sinuses, then gradually narrowed to a slightly obtuse point, and the nervation also, have the same character as those of the living *Liquidambar Styraciflua*. It is true that the four species of this genus known in the present flora have serrate borders of leaves. But three fossil species represented by leaves with entire borders have been described as *Liquidambar* from the Tertiary of Europe; and, though this reference is more or less hypothetical and controverted, it shows, nevertheless, that botanists of high standing—Unger, Watelet, Massalongo—have considered it, at least, as probable. It is easily seen that the leaves of *Aralia Towneri* (pl. vi, fig. 14) have a relation in shape or general outline to those of *Liquidambar integrifolium*, and this apparent similarity can but suggest the possible relation of all these and like forms to the genus *Aralia*. I may admit this relation as probable for the two leaves figured in "Cret. Fl.," pl. xxix, figs. 8 and 9, which are comparable, by their primary nervation, to those of *Aralia concreta* (pl. ix, figs. 3, 5). But though we have now a large number of specimens referable to diverse Araliaceous types, there is none as yet with leaves divided into lanceolate acute lobes like those which are figured in pl. ii, "Cret. Fl.," and with five primary nerves from the base. The reference of these leaves to *Sterculia* has been proposed also, from analogy of forms. But according to the definition of this genus as I admit it for the fossil leaves of the Dakota Group, I refer to it merely tripartite leaves with narrow linear lobes, comparable to those of *Sterculia labrusca*, like those of the few species described in this volume.

A number of vegetable remains of the Cretaceous are evidently referable by their characters to *Populus*. The only fragments of dicotyledonous leaves recognized by Heer, in the specimens which he studied from the Lower Cretaceous formations of Greenland (Kome), represent a *Populus*, appropriately specified by the name of *P. primæva*. From a higher stage of the same Cretaceous formation of that country (Atane) the celebrated Swiss paleontologist has described four other species of *Populus*. In his "Phyllites Crétacées du Nebraska," and from specimens of the Dakota Group, he has recognized *Populus litigiosa*, *Populus* (?) *Debeyana*, and another species still.

P. cyclophylla, described in Proc. Acad. Nat. Sci., Philadelphia. Professor Newberry, in his paper "On the Later Extinct Floras of North America," has described, also, besides the doubtful *P.* (?) *Debeyana*, three new species: *Populus* (?) *cordifolia*, *P. elliptica*, and *P. microphylla*. The specification and the interrogative punctuation applied to some of these names show that the authors themselves do not consider the generic reference as definitive, the character of some of the leaves being somewhat in disagreement with those generally recognized in species of *Populus* of our present time. Indeed, species of this kind, like the present *P. alba*, for example, have such multiplied and diversified forms of leaves, such great variability in their nervation, the mode of attachment, the length of the petiole, etc., that they readily offer, by comparison with fossil leaves of obscure relationship, some points of affinity which, not being found elsewhere, have to be considered by the authors. Hence the doubtful references which may be, and are often, rectified by subsequent discoveries, as is proved by the great proportion of synonyms appended to the enumeration of *Populus* species. To obviate this inconvenient multiplication of fluctuating species of *Populus* I proposed a new generic division, under the name of *Populites*, for the classification of those Cretaceous leaves, numerous indeed, which, partaking of some of the characters of *Populus*, are nevertheless removed from this division by some others, as remarked in the first memoir which I published on some Cretaceous plants from Nebraska.

This paper had to be prepared on short notice from a limited number of specimens, but since its publication I have had opportunity to study the specific forms of the Cretaceous Flora by comparing a very large number of specimens, and have thus been able to recognize a more evident affinity of some of those leaves referred to *Populites* with other generic divisions. *Populites Lancastriensis*, *P. elegans*, which Schimper admits as a true *Populus*, and *Populites cyclophyllus* are the only species preserved in this genus. *P. ovatus*, considered as possibly referable to *Celtis* in Cretaceous Flora, being rather related by its characters to the *Ampelideæ*, is described under the new generic division of *Ampelophyllum*. The affinity of *P. quadrangularis* being more evident with *Alnus*, has been described as *Alnites*. *P. flabellata*, as seen from other specimens, appears to be a deformed leaf of *Greviopsis Haydenii*, and *P. Salisburiæfolia*, being related to *Cissus*, is described as *Cissites*.

In regard to the distribution of *Populus*, to which are referred the most ancient dicotyledonous leaves known as yet, from the Lower Cretaceous of Greenland, the genus has, as said above, three species known already in the Upper Cretaceous of that same country, and five or six in the Dakota Group. It has, however, not been remarked in any Cretaceous Flora of Europe. It is not mentioned in the review of the genera represented by the, as yet, undescribed species of Aix-la-Chapelle,[1] and no form even distantly related is described in the Lower Paleocene Flora of Gelinden. It has, however, one species in the Eocene Flora of Sézanne, and increases in the number of its representatives in all the stages of the European Miocene. As far as we know it, till now, it has few species in our Lower or first American Tertiary Group—the Eocene; has a large proportion, eight per cent. of the species, in the Evanston Group; still more, or twelve per cent., in the Miocene of Carbon, and is present in the second, the Green River Group in four species, three of them of peculiar types, one of which is very abundant.

The presence of Willows (*Salix*) in the Flora of the Dakota Group cannot be controverted, though neither seeds nor scales of this genus have been found as yet. As it is seen in "Cret. Fl.," p. 60, pl. v, figs. 1–4, I have described as referable to one species only a number of leaves somewhat different in size and shape. As the specimens representing them are from the same locality, and as I recognized upon some numerous fragments of leaves a unity of character, size, form, and even texture and color, I considered them as mere varieties of leaves of the same tree. Dr. Newberry has, from the same formation, four species which, he says, he has chosen to regard as distinct, for geological convenience. No *Salix* has been recognized as yet in any stage of the Cretaceous of Greenland; but one species, *Salicites Hartigii*, Dkr., is from the Quader-sandstein of Germany, and another, *Salix Gœtziana*, Heer, from Quedlinburg. The genus is therefore sparingly represented in Europe and North America in Cretaceous Floras which are considered as nearly synchronous.

The other genera of the *Amentaceæ*, *Betula*, *Alnus* or *Alnites*, *Myrica*,

[1] Dr. M. DEBEY has recently published a fine memoir on some querciform leaves found in the sand rocks of Aix-la-Chapelle, Rhenish Prussia.

Quercus, *Fagus*, and *Ficus*, to which leaves have been referred in the Cretaceous Flora, do not require any observations. In this case, as in all the determinations of fossil plants, the characters of the species are not always satisfactorily established, but the generic affinities have been recognized or passed by authors without any marked criticism. The generic relation is specially positive for the remains referable to *Myrica;* one fragmentary leaf and some seeds have been already described in the "Cret. Fl.." while two fine new species are added in this memoir. It seems equally so for *Quercus* or its peculiar division, *Dryophyllum*, of which we have two new species, and for *Ficus*, to which three species are added.

Specimens of leaves referable to *Platanus* have been found in moderate proportion both in Nebraska and Kansas. The first was described by Heer, in the "Phyllites Crétacées du Nebraska," as *Platanus Newberryi*. from a very incomplete fragment. The accuracy of this determination was, however, subsequently verified by the discovery of more complete leaves, figured in "Cret. Fl.," pl. viii, figs. 2 and 3, and pl. ix, fig. 3. which show the narrowed base descending along the petiole lower than the point of union of lateral primary veins, and also the tendency to a three-lobed division, characters which are not observable in the fragment which Professor Heer had for his examination. To this fine species have been added: *Platanus primæva*, described from leaves so remarkably similar to those of *P. aceroides* of the Miocene that I was at first disposed to consider them as identical. I have lately received numerous large leaves of this species with specimens bearing fruits, which, very small, show a great difference from those of the living species; then, *P. Heerii*, rare, like the former, and found, as yet, only along the bluffs of the Salina River; *P. obtusiloba*, from a number of somewhat fragmentary specimens from Beatrice, Nebraska, representing leaves of about the same size and of the same characters; and *P. diminutiva*—all species described and figured in "Cret. Fl." The last one, as remarked in its description, may be a dwarfed form of *P. primæva* or *P. Heerii*. The leaf appears as gnawed along the veins by insects or perhaps by a parasite fungus. Its specification is not positive and is subject to criticisms. The base of the leaf is rounded to the petiole, a character as yet unique for a species of this kind. *P. recurvata* should, following the opinion of my honored friend Saporta, be

referred to the *Araliaceæ* by a more intimate affinity to *Araliopsis* species;[1] and *Platanus affinis* seems now, after the examination and comparison of a number of specimens from Kansas, more evidently referable to the *Ampelideæ* than to the *Platanecæ*. Therefore these last two species are now eliminated from this generic division. The first is now *Araliopsis recurvatus*, the second *Cissites affinis*.

I persist in considering *Platanus Heerii* and *P. obtusiloba* as two different species, though it has been suggested that the last was probably a mere variety of the first. The identity is denied not only by the size, the *facies*, and the nervation of the leaves, but especially by the thinner texture of those of *P. obtusiloba*. The fact that the numerous specimens representing it are all from the same place in Nebraska, and that *P. Heerii* has not been found in that State thus far, confirms this separation. In regard to this last species Professor Geinitz has remarked in "Isis," 1875, p. 558, that paleontologists might, perhaps, recognize in it a *Credneria*. There is, indeed, some similarity in the general outline of the leaves. But this might be said of many of the generic forms of the Cretaceous, which seem referable to a few different types, or to present in one leaf the characters which are now generally found isolated in separate vegetable groups. The genus *Credneria*, known as it is to me by what is described by Stiehler, Vol. V of the "Paleontographica," includes species with cordate or subcordate leaves (none narrowed to the petiole), and bearing above the base two or three true secondary veins at right angles to the midrib. In *P. Heerii* the leaves are cuneate at the base, even gradually narrowed or decurrent on the petiole, which thus becomes slightly winged, and the veins under the primary nerves are mere marginal veinlets. Perhaps the relation of this species is more marked to the genus *Ettingshausenia*, which, I regret to say, is known to me only by supposed synonyms *Chondrophyllum grandidentatum*, as represented by Heer in the Cretaceous Flora of Moletein, and by *Phyllites repandus*, Sternb., two forms which have no affinity to *Platanus*.

The typical character of the Cretaceous species of *Platanus* is more evidently related to the Aralieæ than to any other. This is proved by the reference to that genus of leaves now generally admitted as species of

[1] HEER, in "Arctic Flora," vol. vi, part 2, admits it as Sassafras.

Aralia, as *Platanus grandifolia*, *P. digitata*, *P. Jatropæfolia*, *P. Hercules*, Ung., and *P. latiloba*, Newby. The leaf of *Sassafras* (*Araliopsis*) *Platanoides* (pl. vii, fig. 1) has the *facies* and some of the characters of *Platanus* more distinctly defined than any other of the group; the same characters are even reproduced in *Aspidiophyllum platanifolium* (pl. ii, fig. 4).

The geological distribution of the genus *Platanus* is truly remarkable. No trace of it is recorded as yet in the Cretaceous of Europe, not even in the Paleocene and Eocene of France, so rich in fossil vegetable remains. Its first appearance in Europe is in the Upper Miocene of Oeningen, and of Austria and Italy, where it is represented by two very similar forms, *Platanus Guillelmæ* and *P. aceroides*, two species present in the same formation from the northern parts of the arctic lands to Italy. It is followed in the Upper Tertiary, or Pliocene, of this last country by *Platanus Academiæ*, Gaud., related as progenitor, perhaps, to the living *P. orientalis*. I have remarked above that the relation of leaves of the Dakota Group to *Platanus* has been considered as doubtful by some European paleontologists. This doubt may have been induced by the understanding of the total absence of *Platanus* leaves in the Cretaceous and Lower Tertiary of Europe. If so, it is certainly removed by the presence in our lignitic Eocene of some very beautiful and well characterized species of this genus: *Platanus Haydenii* and *P. Reynoldsii*, Newby. These species, discovered first in the Tertiary of the Upper Missouri River, near Fort Union, are predominant at Golden, Colorado, and are also found at Black Butte Station. The third Tertiary Group, that of Carbon, has, for the more numerous representatives of its Flora, leaves of *Platanus aceroides* and *P. Guillelmæ*. No species of this genus has been described from the Oligocene Green River Group; but we have from the Upper Tertiary (*Pliocene*) of California very fine specimens of leaves of two species, *P. appendiculata* and *P. dissecta*, closely related by their characters to the living *P. occidentalis*. Therefore, and considering the geological records, we may trace the origin of *Platanus* as far down as the North American Cretaceous, and follow its development through nearly all the stages of its Tertiary to our present time, by a number of closely allied intermediate forms.[1]

[1] *Platanus Heerii*, *L.* and *P. affinis L.* are mentioned by Heer in the Cretaceous of Atane, Greenland.

Coming now to the *Laurineæ*, I have to remark somewhat more definitely on the Cretaceous species referred to this family. The relation of some of them to the genera to which they have been referred is generally acknowledged, and the presence of the *Laurineæ* in our Cretaceous Flora receives a kind of historical authority from that of a *Sassafras* in a Cretaceous formation of Greenland,[1] of three species of *Daphnophyllum* in that of Moletein, and of *Laurus cretacea, Daphnogene primigenia, Daphnites Göpperti*, in that of Niedershoena. Of the species which have formerly been described in the Flora of the Dakota Group, *Laurus Nebrascensis* is related to *Daphnophyllum ellipticum* and *D. crassinervium* of Heer, while *Cinnamomum* and *Oreodaphne cretacea* are comparable to *Daphnogene primigenia* of Ettingshausen. *Persea Sternbergii* is also evidently of the same family, and the two leaves, described here below under the name of *Laurus proteæfolia*, are, indeed, allied to species of *Laurus* or of *Persea* by their nervation, especially by the more acute angle of divergence of the lower veins, though they show in the grooved middle nerve a character often remarked in species of *Ficus*, especially *Ficus protogœa*, Heer, of the Greenland Cretaceous Flora. Moreover, the fruit described ("Cret. Fl.," p. 74) as *Laurus macrocarpa* satisfactorily completes the evidence afforded by the leaves of the existence of species of *Laurineæ* in the vegetable world of the Cretaceous epoch. We have, however, to eliminate from this family *Laurophyllum reticulatum*, which appears more properly referable to *Ficus*. Its nervation, and especially its areolation, formed of square or irregularly polygonal meshes by the interposition of tertiary veins between the secondary ones and parallel to them, and the rectangular subdivision of its branches, are of the same character as in *Ficus Geinitzi*, Ett., *Ficus protogœa*, Heer, and as in many species of this genus now growing in Cuba, and even Florida, *Ficus suffocans, F. lentiginosa, F. pertusa, F. dimidiata*, etc. Numerous specimens recently found in Kansas represent the fossil species in characters more precise than formerly, as seen in its more detailed description under the name of *Ficus laurophyllum*.

But if the reference of some of the above-mentioned leaves to the *Laurineæ* is not contested, it is not the same in regard to those which, at

[1] In "Arct. Fl," vol. vi, 2d part, pp. 75–78, HEER describes as new species *Laurus plutonia, L. angusta, L. Hellæ, L. Odini*, with *Cinnamomum Sezannense*, Wat., from the Upper Strata of Atane.

first appearance, were considered as more positively related to this family, and which have been described under the generic name of *Sassafras*. The question of the relation of those leaves which, by their number, seem to be the essential components of the North American Cretaceous Flora, has been already touched upon ("Cret. Fl.," p. 77). But since the publication of that work I have obtained from divers localities a large number of specimens of all the forms described there as species, and I have now some more data to offer to the consideration of paleontologists on the subject.

From historical documents the presence of *Sassafras* species in the Flora of the Dakota Group is as legitimately presumable as that of species of *Laurus* or *Persea*. In his "Flora fossilis arctica," Heer has described as *Sassafras arcticum* a leaf which, by its form, is similar to those described as *Sassafras cretaceum*, as remarked by the author, differing merely by its base tapering somewhat less narrowly to the petiole. The nervation is of the same character. Saporta considers the Greenland leaf as a true representative of *Sassafras*. He has himself published in the "Sézanne Flora,"[1] as *S. primigenium*, two fragmentary leaves whose base, more narrowly tapering, is similar to that of *S. Mudgei* of the "Cret. Fl.," as well as the lobes which, enlarged in the middle, have that ovate-lanceolate shape so distinctly marked in the present *S. officinale*. There is also no appreciable difference in the nervation. The lower secondary veins of the middle lobe ascend a little higher in the leaves of the Sézanne Flora, and unite with those of the lateral lobes somewhat nearer the borders of the sinuses. But in some of the specimens of Kansas the same appearance is remarked also, and the difference between the greater or less distance which separates from the sinuses the branches which unite the upper division of the secondary veins is observable upon leaves of *S. officinale*, this division being sometimes marginal, sometimes curving one to three millimeters lower than the border of the sinuses. Comparing leaves of *Sassafras officinale* with those represented by Saporta in the "Flora of Sézanne" and the specimens of *S. Mudgei* from Kansas, it is impossible for me to recognize any character, even any specific difference, by which these leaves could be separated. It is therefore not surprising that Dr. Newberry first, and after him Heer and Schimper, did consider Cretaceous

[1] P. 366, tab. viii, figs. 9 and 10.

specimens of this kind as representing species of *Sassafras*. In the last volume of his superb work on Vegetable Paleontology,[1] Prof. W. P. Schimper, speaking of leaves of *Sassafras cretaceum*, of which I had sent him photographical designs, remarks: "That those leaves, very variable in size, present such a remarkable likeness to those of *S. officinale*, now living in North America, that one would be disposed to consider them as belonging to a homologous species." He rightly adds that the only difference seems to be in the thicker substance of the fossil leaves. Even on this point I have from Texas specimens of the present *S. officinale*, whose leaves appear of a consistence nearly as thick as it seems to be in those of the Dakota Group.

On the other hand, no species of the *Laurineæ* family living at our time is known with dentate leaves; and it may be remarked, from the figures, that the two leaves described as *Sassafras cretaceum* ("Cret. Fl.," pl. xi, figs. 1 and 2) have the borders of the lobes somewhat dentate, and some of the secondary veins running into the point of the teeth, or craspedodrome. This character is still more marked in *S. mirabile, loc. cit.*, pl. xii, fig. 1, a form extremely common in Southern Kansas, and represented in very numerous and remarkable varieties. In some of the leaves the secondary veins are all camptodrome, and therefore the borders of the lobes are entire. In others, as seen, pl. xi, fig. 2, the outside lateral veins are craspedodrome, and thus the borders are dentate, while on the inside they curve along the borders, which are entire. In the fine complete leaf (fig. 1 of the same plate) the middle lobe has the veins all camptodrome on the left side, while on the right one, a few of them, one or two, reach to the border, which has, therefore, one or two short indistinct teeth, and the lateral lobes are clearly dentate on the outside only. This evidently shows such a disposition to variations of nervation and border divisions, that I formerly considered as unjustifiable a specific, and still more a generic, division between the leaves of pl. xi, figs. 1 and 2, and those of pl. xii, figs. 2 and 3, of the "Cret. Flora." When, therefore, we find the same difference between the leaves which represent *S. mirabile* (pl. xii, fig. 1), it seems that the same conclusion should follow. But in this case, with the more generally predominant character of the indentation of the leaves,

[1] Traité de Paléontologie végétale, vol. iii, p. 298.

which, in some specimens larger than the one figured, are now deeply cut by divisions like pointed lobes, there is still another character, remarked on specimens recently discovered, which seems more forcibly to separate these forms from the *Laurineæ*, and indicates a more evident relation to the *Araliaceæ*. A number of those specimens communicated by M. Chs. Sternberg, to whose careful and zealous researches the Flora of the Dakota Group is indebted for many important discoveries, represent large leaves, which, by the outlines, the nervation, and the dentate borders of the lobes, are like *S. mirabile* of pl. xii, fig. 1. The leaves, however, which are much larger, the lobes measuring as much as ten centimeters in length from the point of union of the primary nerves, greatly differ by the forking of the lateral nerves from a point two and one-half centimeters above their base, thus forming, of course, a subdivision of these lobes into two equal parts, or a palmately five-lobed leaf. They are described as *Sassafras* (*Araliopsis*) *dissectum*. Among the innumerable varieties in the shape of the leaves of the living *Sassafras officinale* we see a constant and gradual mode of division, passing from a round or oval and entire shape to a bilobed and trilobed one; but, as yet, I have been unable to observe a single case of subdivision of the lateral lobes, or to find a palmately five-lobed Sassafras leaf. This character is, on the contrary, far more generally seen in the *Araliaceæ* of our time. Even in a section of the *Araliaceæ*, the genus *Hedera*, whose leaves may be compared to some of those under examination, I do not know any species with trilobate leaves. *Hedera turbascens*, *H. discolor*, *H. argentea*, *H. aurifolia*, *H. jatropæfolia*, have leaves five to seven palmately lobed, or when occasionally trifid their segments are narrow and acuminate. From this the relation of the five palmate leaves to the *Araliaceæ* becomes more evident.

Going further into this kind of investigation, we are met by a new difficulty in the appearance of another modification in the character of this peculiar type of leaves. In examining the first specimens of the species represented (pl. xii and xiv), I could but consider them as representing either *Sassafras* (*Araliopsis*) *obtusum* or *S. mirabile*, the specimens being fragmentary, having only the lobes or part of them preserved. As long as the auricled and peltate base was unknown, the reference of the specimens could not be different. The nervation, the form of the lobes,

their size, all are of the same character as in *S. mirabile*. But in the peltate base of the leaves there is another character which, separately considered, relates the leaves to the *Menispermaceæ*. We thus have *Sassafras* already represented in those leaves by *S. Mudgei*, and less positively by *S. acutilobum; Araliopsis*, to which are referable *S. mirabile*, with the dentate *S. cretaceum*, *S. obtusum*, *S. dissectum*, *S. platanoides*, *Platanus recurvata*, and in a new generic division, under the name of *Aspidiophyllum*, the leaves which, either *Aralia* or *Sassafras*, by their upper trilobate part, are necessarily separated from these genera by their auricled peltate appendage. Still, the subdivisions in the classification of the peculiar and so-called *Sassafras* leaves have to be pursued further, for by degrees and by the gradual obliteration of their lobes they become round or truncate, or broadly pointed at the top, preserving more or less the narrowed base, tapering to a long petiole, and the trifid craspedodrome nervation from a distance above the borders, and thus they become more evidently related to other vegetable orders. One species is a true *Hedera*, another passes to the *Hamamelideæ*, and a number have their affinity with the *Ampelideæ*.

The characters of the leaves of the *Ampelideæ*, especially those of *Cissus*, are somewhat obscurely represented in *Sassafras Harkerianum* ("Cret. Fl.," pl. xi, figs. 3 and 4; pl. xxvii, fig. 2) and in *S. obtusum* (pl. xiii), more distinctly in *Cissites acuminatus* (pl. v, fig. 3) and *C. Heerii* (pl. v, fig. 2), two new species described in this memoir. They appear to constitute an indivisible group. Some of the leaves formerly described as *Populites* are also referable to this section, or to another less exactly defined *Ampelophyllum*, allied by some of its characters to *Hedera*, by others to *Credneria*, thus intermediate between the *Ampelidæ* and the *Tilicaceæ;* by the areolation this genus is related to *Greviopsis*, and also more distantly to *Chondrophyllum* of Heer, as remarked in the description. From this it is perceivable that this *Sassafras* type, which at the beginning was regarded as simple, well defined, and limited in its character, is, on the contrary, multiple, and representing forms which, from increased researches and discoveries, indicate affinity to a number of different genera or orders of the vegetable kingdom.

The same remark is equally applicable to the leaves which have been described in the "Cret. Fl." under the generic name of *Protophyllum*. The

disagreement in the affinities of its species has been explained in the remarks following the description of the genus. I have now to add still to this division two leaves recently communicated from Kansas, represented in pl. iii, fig. 1, and pl. viii, fig. 4. They fully confirm the former observations. By the outline of the leaves, their craspedodrome nervation, and the presence of two pairs of secondary veins under the primary ones and at a right angle to the midrib, they represent a species of *Protophyllum;* but the border base of the leaves is truncate, not subpeltate, and by this difference the leaves are rather referable to *Credneria*, from which, however, they differ by the veins as well as their divisions, being all craspedodrome, and by the truncate, not cordate, base of the leaves. I formerly published a short description of them under the name of *Credneria? microphylla.* It now seems that, by their evident relation to *Protophyllum quadratum*, they have to be admitted in this last generic division, an opinion which may be put at naught by the discovery of specimens pointing to another reference for these leaves.

We have, also, an addition of three new species to the group of Cretaceous plants described under the generic name of *Menispermites.* In this case, however, there is no difficulty whatever in conformably uniting into a definite group the characters of the leaves which, round, ovate, or oval, with borders entire or undulate, have a common generic affinity, indicated by their nervation. In order more clearly to bring into view the relation of the undulate-lobed forms of leaves described in the "Cret. Fl." (pl. xx, figs. 1–4, and pl. xxv, fig. 1), I have represented (pl. xv, fig. 4) a finely and wholly preserved leaf of *Menispermites obtusilobus*, which, though small, is easily identified with the large one of "Cret. Fl." (pl. xxv, fig. 1). Now, comparing it to figs. 2 and 3 of the present pl. xv, the identity of nervation is defined by the five basilar veins, with a thin pair of marginal veinlets underneath; and by the upward direction of the internal lateral veins, which in fig. 4 ascend to above the middle, pass still higher in the short oval leaf, fig. 3, and reach nearly to the obtuse point in fig. 2. The subdivision of the tertiary veins is in all the leaves of the same type, and the shape of the leaves or their outlines are mere modifications, depending upon the direction of the veins. The leaf, fig. 3, is peltate from the point of attachment of the petiole near the middle.

The character of the nervation remains, however, the same. It is somewhat obscured in the figure from indistinctness of the specimen. In figs. 1 and 2, representing leaves entirely preserved and nearly round, the nervation is marked by three pairs of primary nerves on each side of the midrib, and under them by one pair of true marginal veinlets curving on each side toward the borders. Comparing, therefore, these peltate leaves with fig. 4, the position of the petiole is the only notable difference, and the transition to fig. 5 by slight modifications of characters is easily remarked. The peltate form of these round leaves has suggested the fitness of a slight modification in the characters assigned to the genus *Pterospermites* in the "Cret. Fl." (p. 94), the leaves being sometimes rounded or subcordate at base. The difference is immaterial, and is remarked even upon leaves of the same species of *Menispermum* of our epoch. These round peltate leaves, for example, are so much like those of living species of *Cissampelos*, that they rather prove the adaptation of this generic division to all the Cretaceous leaves which I have referred to it.

The *Magnoliaceæ* are more numerously and definitely represented in the North American Cretaceous Flora than they are in that of Europe. *Magnolia alternans* and *M. Capellini* have been described by Heer in his "Phillites Crétacées du Nebraska;" and since that time these two species have been recognized throughout the whole explored area of the Dakota Group, as also in the lower stage of the Cretaceous of New Jersey, and in the Upper Cretaceous of Greenland. *M. speciosa* of Moletein has been discovered in Colorado with a fruiting cone or carpite of this genus. Two other species have been described from the Dakota Group: one, *M. obovata*, by Dr. Newberry, in his "Ancient Floras," another, *M. tenuifolia*, in "Cret. Fl.," and two new ones, *M. obtusata* and *M. Isbergiana*, by Heer, from Atane. In Europe, *M. amplifolia* and *M. speciosa* are described by Heer in the Flora of Moletin—there represented by leaves and fruit.

To the same order belongs *Liriodendron*, so easily recognized by the peculiar form of its leaves. Its Cretaceous origin, or rather existence, is marked in the Dakota Group by a number of specific representatives locally and distantly distributed. The genus is not represented in the Cretaceous Flora of Europe; but in the "Cretaceous Flora of Groenland" Heer describes six varieties of *Liriodendron Meekii* from Atane, and no less than eight

specific forms have been described from Nebraska and Kansas—some of them extremely well defined. This shows, perhaps, more evidently than any other fact remarked on the characters of the plants of the Dakota Group the great disposition to variableness by modification of some characters in the first Dicotyledonous plants. These changes have either caused a multiplication of specific forms preserving traces of the original types in traversing the subsequent geological formations, or have gradually destroyed the number of specific representatives of some genera, as in *Liriodendron*, or even caused the total disappearance of some of the best defined and more predominant types, like those of *Credneria*, *Pterophyllum*, etc. Of these, however, the original characters may have been so widely varied that the ultimate derived forms have not yet been distinctly recognized on plants living now. The two last-named genera, *Credneria* and *Protophyllum*, may possibly be referable to some subdivisions of the *Columniferæ*, the *Buttneriaceæ* and *Pterospermæ*, for example.

The three species which I have described under the insufficiently-defined genus of *Sterculia* are all very uncertain in their relation. As much may be said for the following and last classes of the vegetable kingdom:

To the *Acereæ* is referable *Negundoides acutifolius*. The leaf, however, as seen from pl. xxi, fig. 5, and its description, is too fragmentary for a satisfactory determination of its characters. *Acer antiquum* is described by Ettingshausen in his "Flora of Niedershœna," but from the opinion of the author the reference is uncertain. The leaf rather resembles a deformed form of *Quercus* or of *Liriodendron*. In the same order Heer has, from the Upper Cretaceous of Greenland, a *Sapindus prodromus*, represented by one leaf only, which has evidently the character of the genus. A beautiful species of *Sapindus* described here from Colorado is also present at Atane. This genus is therefore Cretaceous. The reference to the *Rhamnaceæ* of the leaf described as *Rhamnus tenax* in "Cret. Fl." is apparently legitimate, for of the same group three other species, *R. prunifolius*, a *Celastraphyllum*, and an *Ilex*, are described here from the same formation.

To the *Anacardiaceæ* we have probably to refer, as *Rhus Debeyana*, the species described as *Populus* and as *Juglans Debeyana* as seen in "Cret. Fl., p. 110. I have not obtained from the Dakota Group any new materials

comparable to this form, especially common in Nebraska; but I have seen a very fine specimen of it got out of a deep tunnel in Oregon, presenting upon its surface small punctiform protuberances, apparently oily glands, like those remarked upon leaves of the living *Rhus aromatica* and other species of this genus. The leaves are figured (pl. lvi, figs. 5, 6). A species of *Rhus* is described from the Cretaceous of Greenland by Heer, while considering historical authority, we have the same evidence in favor of *Juglans* by a species of this genus in the Cretaceous Flora of Moletein and one in that of Greenland.

Of the *Rosifloreæ* we have from the Dakota Group one leaf and one fruit described as *Prunus*. I have recently received from M. Towner a fruit of the same character upon a specimen bearing leaves of *Aralia Towneri*.

The *Myrtifloræ*, as well as the *Leguminosæ*, present by a number of specimens in the Greenland Cretaceous, have not been thus far positively recognized in Kansas and Nebraska, but seen by one silique only in Colorado.

The few groups not considered in this review have been remarked upon already in the "Cretaceous Flora," and the views in regard to the leaves referred to them have not been modified either by remarks of European authors or by the discovery of new materials.

The want of positiveness in the characters of some of the Cretaceous plants cannot in any way weaken reliance upon the data derived from the exposition of the Flora of the Cretaceous age, nor throw any discredit on the conclusions which they dictate. What the Flora of the Dakota Group positively shows is a great predominance of dicotyledonous plants in its composition; and that is all that may be positively known as yet of the remarkable change it attests in the vegetation of that period. The causes, the mode of proceeding of nature, either by slow, gradual, or by rapid modifications, remains as yet inscrutable. But the characters of dicotyledonous leaves cannot be mistaken; the relation of most of them to groups of plants of the present Flora possesses positive evidence. The *Cupuliferæ* with species of *Quercus* and *Fagus;* the *Salicineæ* with species of *Populus;* the *Plataneæ* with *Platanus primæva*, leaves and fruits; the *Laurineæ*, represented also by leaves and a fruit of *Laurus*, by leaves of *Persea, Cinnamomum, Sassafras;* the *Araliaceæ*, the *Magnoliaceæ*, with fruits and leaves;

the numerous forms of leaves of *Liriodendron*, so peculiar that they cannot be mistaken for those of any other group or plant; even the *Menispermaceæ* constitute, by their fossil remains, vegetable groups quite as definite as they could be established from living plants.

Since the publication of the "Cretaceous Flora" (vol. vi of the U. S. Geological Reports of Dr. F. V. Hayden) the character of the vegetation of the Middle Cretaceous as represented in the Dakota Group has become better defined by the discovery of a large number of specimens of fossil plants, which have increased from 130 to 190 the number of vegetable forms considered specific, already known from this formation. The whole Flora of the Cenomanian epoch, as it is shown in the table of distribution, is composed of 446 species, of which 310 are dicotyledonous and 130 are cryptogamous and gymnospermous plants. Of the 190 species of the Dakota Group, 162 are dicotyledonous and only 28 represent crytogamous and gymnospermous plants.

Numerous works on the Jurassic Flora have sufficiently proven that up to its upper member the Wealden, or lower Neocomian, it is entirely composed of gymnospermous and cryptogamous plants—especially Ferns, *Cycadeæ*, and Conifers. The Neocomian, whose vegetation is but little known as yet, shows in its remains the same constituents of its Flora. Upon it is superposed in Germany the upper Neocomian, or Urgonian, from which a series of fossil plants, 22 in number, have been described by Schenk from the Wernsdorf-Schichten of the Carpathian Mountains of Austria; and there also no dicotyledonous plant has been found, and nothing indicates the decadence of the reign of the gymnospermous plants or shows any kind of difference which could lead one to presage the appearance of the Dicotyledons.

We owe to Heer the most interesting documents on the characters of the vegetation of the Middle Cretaceous—first by the publication of the Flora of Kome, and then of that of Atane, both in Greenland.

The Flora of Kome, composed of 85 species, has, says the author, its greatest affinity with that of the Wernsdorf shale or upper Neocomian on one side, and with that of the Wealden on the other. With the plants of the higher Cretaceous stages it has only 7 species—Ferns and Conifers—in common. Most of the specimens of the group submitted to Heer's

examination have been obtained on the peninsula of Noursoak (70° 37′ N.), from beds of shale alternating with banks of sandstone, the whole overlying granite or primitive formation. One of the localities, that of Elkorfat, is 500 feet above that of Kome, but the plants are of the same kind. The vegetable remains belong mostly to cryptogamous and gymnospermous plants: 41 Ferns, 1 Marsilia, 1 Lycopod, 3 *Equisetaceæ*, 10 *Cycadeæ*, 21 Conifers, 6 Monocotyledons, and a single Dicotyledonous species.

On the south side of the same peninsula of Noursoak, near Atane, at an elevation of 650 feet above the sea, another lot of plant-remains, collected also by the expeditions of Nordenskjöld, and submitted to Prof. Heer for examination, represents a Flora composed of far different elements. It has 170 species: 3 Fungi, 31 Ferns, 1 Marsilia, 1 Selaginella, 1 Equisetum, 8 *Cycadeæ*, 27 Conifers, 8 Monocotyledonous, and 97 Dicotyledonous plants. These, therefore, constitute more than one-half of the vegetation.[1] The celebrated author remarks, on the geological relation indicated by the characters of the plants, that it is not possible to determine it positively, as the plants of the Cretaceous are, as yet, too little known. But he admits that the formation of Atane, considering its vegetable remains, is probably referable to the lower Cenomanian.

As will be seen in the examination made of the age of the Dakota Group, from data shown in the table of distribution, its Flora seems to be somewhat more recent than that of Atane, though the relationship is very close. The general character of the plants does not greatly differ, but the number of the dicotyledonous plants is much greater, amounting in the Flora of the Dakota Group to more than five-sixths of the vegetation.

In considering merely what is now known of the vegetation of the Middle Cretaceous (the Cenomanian of d'Orbigny), the first appearance, and especially the prodigious development, of the Dicotyledons seems the more wonderful that it is not a local phenomenon, but is remarked in the formations of the same age over the whole Northern hemisphere. We cannot yet follow it in all the intervening land areas, but it has been traced from Greenland to Vancouver Island to Canada, to Kansas, and Colorado, and in Europe to Germany, therefore in about 40° N. latitude.

[1] These data are taken from HEER'S "Groenland Flora," vol. vi, part 2.

With the limited acquaintance we have with the ancient Floras of the world it is not possible to account for the sudden appearance of the Dicotyledons in the Cretaceous time and for their rapid and wide distribution. Saporta, justly considered as the botanist who has acquired by his vast knowledge the most extensive views on the distribution of the vegetation in the ancient epochs, says, on the subject:[1] "The organic evolution to which the Dicotyledons owe their existence and their distribution must have been produced under the influence of very different conditions. It is possible that the evolution has been originally slow and obscure; possibly also it has been accomplished in a concealed or as yet undiscovered locality, in a separate region, and under the influence of peculiar local circumstances. It is probable that the change may have been accomplished by the mediation of insects, multiplying at a given time the results of crossing and producing some combinations favorable to the growth of these plants. It is even conceivable that a short time may have been sufficient to give origin to plants of this class under the action of causes which are still unknown. Whatever hypothesis may be preferred, the fact of the rapid multiplication of the Dicotyledons and of their simultaneous occurrence in many localities of the Northern Hemisphere from the beginning of the Cretaceous Cenomanian cannot be contested."

Yes, in this case, as in many others, we may collect facts, but the work of nature in its mode of proceeding for the creation or modification of species remains inscrutable. We may consider the formation of the Dakota Group as produced by a very slow, gradual, prolonged depression of the Western slope of the continent, bringing up from the South or West the invasion of ocean water charged with muddy materials, periodically heaped farther and farther inland by powerful tides. We may suppose, too, the invading flow as bringing with it seeds or fragments of roots of plants derived from a country now covered by the sea, and distributing here and there those germs of vegetable organisms. But all this does not account for much in the solution of the problem; it may explain the distribution; but the first appearance, and it seems the simultaneous multiplication, of the dicotyledonous plants remains a fact inconceivable to reason.

[1] "Le monde des Plantes," etc., p. 197.

THE FLORA OF THE GREEN RIVER GROUP.

GEOLOGICAL DISTRIBUTION OF THE MEASURES.

In my preceding Reports I have referred to the Green River Group a limited number of species of fossil plants obtained from different localities mentioned below, and which were formerly considered as pertaining to the same geological stage. Now this group includes four members: the lower, the Wasatch, of which the Green River is an upper member; then, in ascending, the Bridger, the Uinta, and the White River with the Oregon beds.

The name of the Green River Group was proposed by Dr. F. V. Hayden on account of the great extent, thickness, and display of strata of this formation along Green River in Wyoming.

The formation as it is seen there is purely of a fresh-water origin and seems to be a continuation of the Eocene Laramie Group, or Lignitic, its strata being conformable to it and the modifications of the compounds being gradual. The lower member of the measures is mostly composed of arenaceous beds, the upper a series of laminated shale, each of these members averaging about one thousand feet in thickness.

The upper part of the measures merit especially to be considered now, as from it are derived the fossil remains which have been described here as derived from the Green River Group.

The shale, variegated in color, mostly red and white, and variable in thickness, give to the measures a peculiar banded appearance, especially marked near Green River Station, where I had an opportunity to make some observations on the distribution of the strata. At this place a section of 550 feet from the bed of the river to the high round bluff towering there over the country around shows the multiplicity of the layers and the variety of the compound.[1] The upper part of the bluff is a hard ferru-

[1] Hayden's "Annual Report," 1872, p. 336, where the section is given in detail.

ginous red sandstone in layers varying from 6 inches to 1 foot; below this there are 55 feet of laminated argillaceous sandstone with remains of fishes and plants intercalated between distinct slaty layers ¼ to 1 inch thick; then five beds of black bituminous compact shale measuring 2, 5, 25 feet, separated by beds of white calcareous shale, sandstone in thin layers, etc. Few of the beds are compact and homogeneous except the bituminous shale. The intercalated sandstone, four beds, variable from 5 to 13 feet, are composed of shaly layers. Near the base of the section only there is a bed of hard calcareous somewhat compact rock, which I have not remarked elsewhere in the country around.

The localities where fossil plants formerly referred to the Green River Group have been obtained are near Alkali Stage Station and Green River Station, Wyoming; in Randolph County of the same State; near Elko Station, on the U. P. Railroad, in Nevada; near the mouth of White River, Utah; and especially at Florissant, a locality also mentioned as Castello's Ranch and South Park, in Colorado.

The beds[1] of Florissant, now generally known for the abundance of their fossil remains, plants and insects especially, have been formed by like deposits. The geologist, Dr. A. C. Peale, one of the assistants of Dr. F. V. Hayden in his Survey of the Territories, has first given a short account of the formation near Florissant, a settlement rather than a village, situated in a narrow valley of the mountains, at the southern extremity of the Front Range of Colorado. He says: "In this valley, the name of Hayden Park has been given to the low rolling country to the west of Pike's Peak. Hayden Park is drained by Front Creek, West Creek, and Beaver Creek. The latter flows to the northwest and empties into the South Platte just below the upper cañon. About five miles from its mouth, around the settlement of Florissant, is an irregular basin filled with modern deposits. The entire basin is not more than five miles in diameter. The deposits extend up the branches of the creek, which all unite near Florissant. Between the branches are granite islands appearing above the beds which themselves rest on the granite. Just below Florissant, on the north side of the road, are bluffs not over 50 feet in height,

[1] Dr. Hayden's "Annual Report, U. S. Geological Survey of the Territories," 1873, p. 200.

in which are good exposures of the various beds. The following section gives them from top downward:

"1. Coarse conglomerated sandstone.

"2. Fine-grained, soft, yellowish-white sandstone, more or less argillaceous, and containing fragments of stems and leaves.

"3. Coarse gray and yellow sandstone.

"4. Chocolate-colored clay shales with fossil leaves. At the upper part the shales are black, and below pass into—

"5. Whitish clay shales.

"These last form the base of the hill. The beds are all horizontal."

After remarking on the presence of fragments of trachyte scattered around and found in layers near the surface, as seen by the boring of a well in the vicinity, Dr. Peale continues: "The lake basin may possibly be one of a chain of lakes that extended southward. I had thought it possible that the beds were of Pliocene age. The specimens obtained from No. 4 of the section above were submitted to Mr. Lesquereux, who informs me that they are Upper Tertiary, and says that he does not believe, as yet, that the plants of the Green River Group, to which are referable the specimens sent to him, authorize the conclusion of Pliocene age. He rather considers them, as yet, as Upper Miocene. The species known of our Upper Tertiary are, as yet, too few and represented in too poor specimens for definitive conclusion. Those sent from Florissant have a *Myrica*, a *Cassia*, fragments of leaves of *Salix angustata*, Al. Br., a *Rhus*, an *Ulmus*, and a fragment of *Poa* or *Poacites*."

I give the end of the quotation in order to show that the first opinion I expressed on the age of the Green River Group from its vegetable remains was based upon the examination of too insufficient materials.

After Dr. Peale the lake basin of Florissant has been carefully explored by Professor Sam. H. Scudder, who, in "Bulletin of the Geol. Survey," vol. vi, No. 2, has given in great detail the most precise and interesting account of his researches. It comprises not only the topographical description of the basin, the geology and stratigraphy of the beds formed by deposits of the lake, but a preliminary report on the insects and the plants obtained there by himself in an immense number

of specimens. From this valuable memoir are derived a few notes which complete what the paleontologist may wish to know in regard to the strata from which the fossil remains are derived.

Professor Scudder's memoir is elucidated by a map of the Tertiary basin of Florissant as it was at the time when the strata were deposited. The area was then covered by a shallow sheet of water, hemmed in on all sides by near granite hills whose wooded slopes come to the water's edge, sometimes, especially on the northern and eastern sides, rising abruptly; at others gradually sloping so that reeds and flags grew in the shallow water by the shore; the water of the lake, penetrated by deep inlets between the hills, giving to it a varied and tortuous outline. This old lake was really a long outlet following the bottom of the valley, and expanding on both sides in lateral long shallow straits or pools. In one place the lake is contracted to half a mile in width; at two others one-fourth of a mile; taken altogether it is on an average 1 mile broad, being 6 to 7 miles long, expanding, on the eastern side especially, into nine of those narrow shallow straits. The outlines of the straits are, of course, varied. The area covered by their water measured half a mile to a mile long, one-fourth to half a mile broad, so that the shape of that Tertiary lake, as it is represented upon the map, resembles an oblong leaf, lobate on the borders, somewhat like a leaf of the white oak. It is easy to understand how those shallow pools, penetrating between hills covered with deep forest, alternately drying in summer and filling up in the rainy season, could become the reservoirs of woody and animal débris thrown upon their surface from overhanging trees and rocks, and there periodically accumulating by the succession of dryness and flood.

Professor Scudder supposes that the ancient outlet of the whole system was at the southern extremity; at least, the marks of the lake deposits reach near the ridge which now separates the waters of the Platte and of the Arkansas; and the nature of the basin itself, the much more rapid descent of the present surface on the southern side of the division, with the absence of any lacustrine deposits upon its slopes, lead to this conclusion.

Says Professor Scudder: "The very shales of the lake itself, in which

the myriad of plants and insects are entombed, are wholly composed of volcanic sand and ash; 50 feet or more thick, they lie in alternating layers of coarser and finer materials. About half of this, now lying beneath the general surface of the ground, consists of heavily bedded drab shales with a conchoidal fracture, and totally destitute of fossils. The upper half has been eroded and carried away, leaving, however, the fragmentary remains of this great ash deposit clinging to the borders of the basin and surrounding the islands; a more convenient arrangement for the present explorer could not have been devised. That the source of volcanic ashes must have been close at hand seems abundantly proved by the difference in the deposits at the extreme ends of the lake. Not only does the thickness of the beds differ at the two points, but it is difficult to bring them into anything beyond the most general concordance.

"The excavation of the filled-up basin we must presume to be due to the ordinary agencies of atmospheric erosion. The islands in the lower lake take now as then the form of the granitic nucleus; nearly all are long and narrow, but their trend is in every direction, both across and along the valley in which they rest. Great masses of the shales still adhere equally on every side to the rocks against which they are deposited, proving that time alone, and no rude agency, has degraded the ancient flora of the lake."

The examination of Professor Scudder of the deposits of this lacustrine basin was principally made in a small hill, from which, perhaps, the largest number of fossils have been taken, lying just south of the house of Mr. Adam Hill and upon his ranch. "Like the other ancient islets of this upland lake it now forms a mesa, or flat-topped hill, about 30 to 50 feet high, perhaps 300 feet long and 80 broad. Around its eastern base are the famous petrified trees, huge, upright trunks, standing as they grew, which are reported to have been 18 to 20 feet high at the advent of the present residents of the region. Piecemeal they have been destroyed by vandal tourists, until now not one of them rises more than 2 or 3 feet above the surface of the ground, and many of them are entirely leveled; but their huge size is attested by the relics, the largest of which can be seen to have been 10 to 15 feet in diameter. These gigantic trees appear

to be Sequoias, as far as can be told from thin sections of the wood submitted to Dr. L. Goodale. As is well known, remains of more than one species of *Sequoia* have been found in the shales at their base.

"From what information we could gain of the wells in this neighborhood, it would appear that the present bed of the ancient Florissant lake is entirely similar in composition for at least 30 feet below the surface, consisting of heavily bedded non-fossiliferous shales having conchoidal fracture. Above these basal deposits, on the slope of the hill, we found the following series from above downward, commencing with the evenly bedded strata:

"*Section in Southern Lake—By S. H. Scudder and A. Lakes.*

	Ft.	In.
1. Finely laminated, evenly bedded, light-gray shale; plants and insects scarce and poorly preserved	1	2
2. Light-brown, soft and pliable, fine-grained sandstone; unfossiliferous	2	0
3. Coarser, ferruginous sandstone; unfossiliferous	1	4
4. Resembling No. 1, leaves and insect remains	8	2
5. Hard, compact, grayish-black shale, breaking with a conchoidal fracture, seamed in the middle with a narrow strip of drab shale; fragments of plants	11	0
6. Ferruginous shale; unfossiliferous	5	0
7. Resembling No. 5, but having no conchoidal fracture; stems of plants, insects, and a small bivalve mollusk	3	4
8. Very fine gray ochreous shale; non-fossiliferous	0	2
9. Drab shales, interlaminated with finely divided paper shales of a light-gray color; stems of plants, reeds, insects	18	0
10. Crumbling ochreous shale; leaves abundant, insects rare	3	0
11. Drab shales; no fossils	3	0
12. Coarse ferruginous sandstone; no fossils	1	4
13. Very hard drab shales, having a conchoidal fracture and filled with nodules; unfossiliferous	24	7
14. Finely laminated yellowish or drab shales; leaves and fragments of plants, with a few insects	11	6

	Ft.	In.
15. Alternating layers of darker and lighter gray and brown ferruginous sandstone; no fossils	4	0
16. Drab shales; leaves, seeds, and other parts of plants, and insects, all in abundance	24	0
17. Ferruginous, porous, sandy shale; no fossils	2	4
18. Dark-gray and yellow shales; leaves and other parts of plants	3	4
19. Interstratified shales, resembling Nos. 17 and 18; leaves and other parts of plants, with insects	7	0
20. Thickly bedded chocolate-colored shales; no fossils	17	0
21. Porous yellow shale, interstratified with seams of very thin drab-colored shales; plants	3	0
22. Heavily bedded chocolate-colored shales; no fossils	11	6
23. Thinly bedded drab shales; perfect leaves, with perfect and imperfect fragments of plants and a few broken insects	7	6
24. Thinly bedded light-drab shales, weathering, very light; without fossils; passing into	7	6
25. Thick-bedded drab shales, breaking with a conchoidal fracture; also destitute of fossils	7	0
26. Coarse arenaceous shale; unfossiliferous	3	4
27. Gray sandstone, containing decomposing fragments of some white mineral, perhaps calcite; no fossils	70	0
28. Coarse, ferruginous, friable sandstone, with concretions of a softer material; fragments of stems	23	0
29. Thinly bedded drab shales, having a conchoidal fracture; somewhat lignitic, with fragments of roots, etc	10	0
30. Dark chocolate shales, containing yellowish concretions; filled with stems and roots of plants	10	0
Total thickness of evenly-bedded shales (D. of Dr. Wadsworth's note) above floor deposits	23	0

"The bed which has been most worked for insects and leaves, and in which they are unquestionably the most abundant and best preserved, is the thick bed, No. 16, lying half way up the hill, and composed of rapidly alternating beds of variously-colored drab shales. Below this, insects were plentiful only in No. 19, and above it in Nos. 7 and 9; in other beds

they occurred only rarely or in fragments. Plants were always abundant where insects were found, but also occurred in many strata where insects were either not discovered—such as beds 18 and 21 in the lower half and bed 6 in the upper half—or were rare, as in beds 10 and 14 above the middle and bed 23 below; the coarser lignites occurred only near the base.

"The thickest unfossiliferous beds, Nos. 20 and 27, were almost uniform in character throughout, and did not readily split into laminæ, indicating an enormous shower of ashes or a mud-flow at the time of their deposition; their character was similar to that of the floor-beds of the basin.

"These beds of shale vary in color from yellow to dark brown. Above them all lay, as already stated, from 4 to 6 feet of coarser more granulated sediments, all but the lower bed broken up and greatly contorted. These reached almost to the summit of the mesa, which was strewn with granitic gravel and a few pebbles of lava."

The specimens of Florissant representing the plants described in this memoir were mostly obtained by Professor Scudder, who had opportunity to purchase for Dr. Hayden a collection made by Mrs. Charlotte Hill, the proprietress of the land where are exposed the banks containing the richest fossiliferous shale. A little later a scientific exploration for the College of Princeton visited the same locality and obtained there also a great number of specimens; some of these, very fine, which were loaned me for examination, have been figured and described in this report. I have been allowed to use the names of some of the members of the exploration—Messrs. W. B. Scott, H. F. Osborn, F. Speir, McCosh, W. Libbey—for the nomenclature of some of the new species which are represented by the Princeton specimens.

ENUMERATION AND DESCRIPTION OF THE SPECIES OF FOSSIL PLANTS KNOWN FROM THE GREEN RIVER GROUP.

CRYPTOGAMÆ.

FUNGI.

Sphaeria myricæ, Lesqx.

"U. S. Geol. Rep.," vii, p. 34, pl. ii, fig. 4.

CHARACEÆ.

CHARA, Waill.

Chara? glomerata, sp. nov.

Plate XXI, Fig. 12.

Leaves short, in compact, dense, distant or terminal capitules; stem narrow.

These fragments are not positively referable to *Chara* on account of the compactness and shortness of the leaves. The branches bearing the capitules are smooth, flexuous, the leaves ? apparently subcylindrical, acute. They may represent flower-bearing pedicels of *Platanus* like *P. racemosa*, Nutt. They, however, can scarcely be considered as such, for not the least fragment of *Platanus* leaves has been found as yet in the Green River Group.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

MUSCI.

FONTINALIS, Linn.

Fontinalis pristina, sp. nov.

Plate XXI, Fig. 9.

Leaves obscurely two-ranked, crowded, linear-lanceolate, acuminate, ecostate.

The leaves are close, gradually enlarged toward the embracing base, about one centimeter long, very narrow.

Hab.—Florissant, Colorado. The locality indicated as Castello's ranch is the same.

HYPNUM, Linn.

Hypnum Haydenii, Lesqx.

"U. S. Geol. Rep.," vii, p. 44, pl. v, figs. 14–14*b*.

RHIZOCARPEÆ.

SALVINIA, Mich.

Salvinia cyclophylla, Lesqx.

"U. S. Geol. Rep.," vii, p. 64, pl. v, figs. 10, 10*a*.

Salvinia Alleni, Lesqx.

Plate XXI, Figs. 10, 11.

"U. S. Geol. Rep.," vii, p. 65, pl. v, fig. 11.

The species is common and has been obtained in large well-preserved specimens by the different collectors. The leaves are merely variable in size, obtuse or slightly emarginate at the apex, topped by the point of the excurrent nerve.

EQUISETACEÆ.

EQUISETUM, Linn.

Equisetum Wyomingense, Lesqx.

"U. S. Geol. Rep.," vii, p. 69, pl. vi, figs. 8–11.

Equisetum Haydenii, Lesqx.

"U. S. Geol. Rep.," vii, p. 67, pl. vi, figs. 2–4.

ISOETEÆ.

ISOETES ?, Web.

Isoetes brevifolius, sp. nov.

Tufts small, compact; leaves cylindrical, acuminate, coming out of a small cylindrical stem or rhizoma.

The leaves are 1 to 2 millimeters in diameter, 4 to 6 centimeters long, narrowed to a point, apparently smooth. The small tufts much resemble *Isoetes Braunii*, Heer, as figured in "Fl. Tert. Helv.," pl. xiv, fig. 5, the leaves being only shorter and narrower.

Hab.—Florissant. Specimen No. 66 of the collection of Mr. R. D. Lacoe, of Pittston, Penna.

LYCOPODIACEÆ.

LYCOPODIUM, Linn.

Lycopodium prominens, Lesqx.

"U. S. Geol. Rep.," vii, p. 45, pl. v, figs. 13–13*b*.

FILICES.

SPHENOPTERIS, Phill.

Sphenopteris Guyottii, sp. nov.

Plate XXI, Figs. 1–7.

Ultimate pinnæ linear-lanceolate, of various lengths; rachis narrow and narrowly winged by the decurrent base of the lanceolate obtuse pinnules; lower pinnules regularly divided into 2 to 4 half-round short lobes, connate in the middle; upper pinnules entire, oblong, obtuse; medial nerve thin, pinnately branching into oblique lateral nerves, generally forking once, rarely simple; substance of the leaves rather thin; nervation distinct.

This fern, common at Florissant, but always found in small fragments, has no near relation to any fossil species known to me, being only comparable to *Sphenopteris Blomstrandi*, Heer, "Fl. Arct." i, p. 155, pl. xxix, figs. 1–5, from the Miocene of Spitzbergen. In its form and its nervation it is a true *Phegopteris*, closely related to some Cuban species, *P. sericea*, *P. divergens*, &c. But from the absence of fructification an exact comparison is not possible.

Hab.—Florissant. Seen in most of the collections.

ADIANTITES, Auct.

Adiantites gracillimus, sp. nov.

Plate XXI, Fig. 8.

Rachis very slender, filiform, flexuous, bearing at its top a few simple entire pinnules, oval in outline, sessile by the cuneate base, obtuse; nervation dichotomous, the medial nerves forking two or three times; branches very oblique, forking near the apex.

I have seen only the small fragment figured, which is, however, distinctly preserved. By the disposition of the leaflets and their shape it may be compared to *Asplenites allosuroides*, Ung., "Fl. v. Sotzka," which has small fructified pinnules: but the nervation is that of *Adiantum*.

Hab.—Florissant.

LASTRÆA, Presl.

Lastræa (Goniopteris) intermedia, Lesqx.

"U. S. Geol. Rep.," vii, p. 56, pl. iv, fig. 14.

PTERIS, Linn.

Pteris pseudo-pennæformis, Lesqx.

Ibid., p. 52, pl. iv, figs. 3, 4.

DIPLAZIUM, Swartz.

Diplazium Muelleri, Heer.

Ibid., p. 55, pl. iv, figs. 10, 10*a*.

LYGODIUM, Sw.

Lygodium neuropteroides, Lesqx.

Ibid., p. 61, pl. v, figs. 4–7; vi, fig. 1.

Lygodium Dentoni, Lesqx.

Ibid., p. 63, pl. lxv, figs. 12, 13.

CONIFERÆ.

PINUS, Linn.

Pinus Florissanti, sp. nov.

Plate XXI, Fig. 13.

Strobile large, conical, 12 centimeters long or more, 6 centimeters in diameter at the broken base; scales large, 4½ centimeters long, 1½ broad; apophyses conical, transversely rhomboidal when flattened.

This fine cone is related to *Pinus ponderosa*, Douglas, a fine species of California and New Mexico, by the large size of the scales, not or scarcely enlarged under the apophyses.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Pinus palæostrobus ?, Ett.

"U. S. Geol. Rep.," vii, p. 83, pl. vii, figs. 25, 31.

SEQUOIA, Torr.

Sequoia angustifolia, Lesqx.

Ibid. p. 77, pl. vii, figs. 6–10.

Sequoia Langsdorfii, Brgt.

Ibid., p. 76.

Sequoia Heerii, Lesqx.

Ibid., p. 77, pl. vii, figs. 11–13.

Sequoia affinis, Lesqx.

Ibid., p. 75, pl. vii, figs. 3–5; lxv, figs. 1–4.

TAXODIUM, Rich.

Taxodium distichum miocenum, Heer.

"U. S. Geol. Rep.," vii, p. 73, pl. vi, figs. 12–14.
Abies Nevadensis, Lesqx., "Hayden's Ann. Rep.," 1872, p. 372.

WIDDRINGTONIA, Endl.

Widdringtonia linguæfolia, sp. nov.

Plate XXI, Figs. 14, 14*a*.

Glyptostrobus Europæus, Lesqx., "U. S. Geol. Rep.," vii, p. 74, pl. vii, figs. 1, 2.

Branches and branchlets short, pinnately divided; divisions alternate; branchlets simple and slender; leaves appressed, irregularly two-ranked or subalternate, ovate, blunt-pointed or lingulate.

The specimens represent two forms of the same species, differing merely by the size or the thickness of the branches and branchlets. The more common form is figured; the other is more slender in all its parts, a var. *gracilis*, mentioned in "Hayden's Ann. Rep.," 1872, p. 371, as *Thuites callitrina*, Ung.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

THUYA, Linn.

Thuya Garmani, Lesqx.

Hayden's "Ann. Rep.," 1872, p. 372.

GLYPTOSTROBUS, Endl.

Glyptostrobus Ungeri ?, Heer.

Plate XXII, Figs. 1–5*a*.

Heer, "Fl. Tert. Helv.," i, p. 52, pl. xviii; "Fl. Alask.," p. 22, pl. iii, figs. 10, 11.

Stem leaves squamiform, appressed, lanceolate, acute or acuminate; branch-leaves open, two-ranked, much longer, linear-lanceolate, acute; male cone small, oval, terminal; strobiles ovate on short branches; scales 6 to 9, obtusely dentate at the upper border, obscurely striate lengthwise.

This species, obtained in fine specimens, is in some of its characters identical with *Cupressites taxiformis*, Ung., "Chloris," p. 18, pls. viii and ix. The diversity of the leaves in regard to their position upon the stem and the base of the branches, where they are shorter, appressed, and squamiform, is not indicated by Unger. It seems also to be identical to *Chamæcyparites Hardtii*, Endl., as represented by Ett., "Häring Fl.," p. 35, pl. vi, figs. 1–21, two species referred by Schimper to *Sequoia Langsdorfii*, Brgt. The cones of the species of Florissant, however, are not those of a *Sequoia*

but of a *Glyptostrobus*, and these, like the diversity in the form of the leaves, agree in character with *G. Ungeri*, Heer, quoted above, which is now considered by the author as a variety of *G. Europæus*. The cones only are somewhat larger, as figured by Heer, and the stem leaves rather obtuse than acuminate. As in the "Flora of Alaska," the same author represents these scaliform leaves acute, even acuminate, and as in that of Spitzbergen ("Fl. Arct.," iv, pl. xi, figs. 2–8) the same kind of leaves are either obtuse or acuminate, the reference of the American form to the species of Heer is sufficiently authorized. The species is closely related to *Glyptostrobus heterophyllus*, Endl., of China, the only living species of this genus.

Hab.—Very common at Florissant. The specimens figured are mostly those of the Princeton Museum.

PODOCARPUS, L'Hérit.

Podocarpus coccnica ?, Ung.

Leaves narrowly linear-lanceolate, acute, narrowed into a short petiole; medial nerve distinct.

This description refers to two leaves which agree with the description and figure of this species by Unger ("Fl. of Sotzka," p. 28, pl. ii, figs. 11–16). The medial nerve is flat and comparatively broad; the leaves are slightly broader in the middle.

Hab.—Florissant. No. 68 of Lacoe Collection.

GRAMINEÆ.

POACITES, Heer.

Poacites lævis, Heer.

Hayden's "Ann. Rep.," 1871, p. 285.

CYPERUS.

Cyperus Chavannesi, Heer.

"U. S. Geol. Rep.," vii, p. 92, pl. ix, figs. 1, 2.

CYPERITES, Lindl.

Cyperites Haydenii, sp. nov.

Plate XXIII, Figs. 1–3*a*.

Leaves large, gradually enlarging upward from its root, linear above; medial nerve broad and flat; lateral nerve parallel, distinct to the eye, separated by four or five very thin intermediate veins.

From the fragments preserved the leaves appear to have been very long. Linear in the middle where they are 3 centimeters broad, they are slightly narrower upward and apparently rounded to a pointed apex, gradually tapering downward to the upper part of the root, a small tubercle. The medial nerve, quite distinct, is 2 millimeters broad in the middle. Though related to *Cyperus* and *Cyperites*, this leaf has no marked affinity to any one of the numerous forms which have been described under this name. The leaf is quite flat and does not appear to have been keeled in the middle, but distinctly nerved. It comes out directly from the tubercle. The lateral nerves, 12 to 14, are separated by veinlets without any transverse veins.

Hab.—Randolph Co., Colorado. U. S. Geol. Expl. Dr. *F. V. Hayden.*

ARUNDO, Linn.

Arundo Goepperti ?, Münst.

"U. S. Geol. Rep.," vii, p. 86, pl. viii, figs. 3–5.

Arundo reperta, Lesqx.

Ibid., p. 87, pl. viii, figs. 6, 8.

PHRAGMITES, Trin.

Phragmites Alaskana, Heer.

Ibid., pl. viii, figs. 10–12.

TYPHACEÆ.

TYPHA.

Typha latissima, Al. Br.

Plate XXIII, Figs. 4, 4*a*.

Al. Br., "Stizenb. Verz.," p. 75; Heer, "Fl. Tert. Helv.," i, p. 98, pl. xliii, xliv; "Mioc. Balt. Fl.," p. 29, pl. iv, fig. 11; Ett., "Foss. Fl. v. Bilin," p. 30, pl. vi, fig. 9.

Leaves very long, 2 to 3 centimeters broad, linear, marked lengthwise by parallel strong nerves (14) crossed at right angles by transverse thin lines; intermedial veinlets numerous (10–13).

Though these fragments, which are numerous, and part of which only are figured, are referable to the European species by their appearance, they may represent a different one on account of the numerous intermediate veinlets which separate the primary nerves. In the European species only 4 to 6 are counted, while on the American specimens they are generally 10 to 12. It is, however, to be remarked that *Typha* species living at the

present epoch have a wide range of distribution; the two species (*T. latifolia* and *T. angustifolia*) are as common on the North American continent as they are in Europe.

Hab.—Florissant; Randolph County. U. S. Geol. Expl. Dr. *Hayden.*

POTAMOGETON, Linn.

Potamogeton? verticillatus, sp. nov.

Plate XXIII, Figs. 5, 6.

Stems slender; leaves verticillate or tufted, grass-like, linear-lanceolate, largest toward the base, sessile and narrowed to the point of attachment, nerved lengthwise in the middle; branches very slender, floating or pendant, bearing tufts of shorter leaves.

This species differs from its congeners by the position of the leaves in verticils upon apparently articulate stems. It is distantly related to *P. cæspitans*, Sap., "Ét.," i, p. 76, pl. iv, fig. 2.

Hab.—Florissant. The specimen (fig. 5) is from the Explor. of Dr. *F. V. Hayden;* the other belongs to the Princeton Museum.

Potamogeton geniculatus, Al. Br.

"Stizenb. Verz.," p. 75; Heer, "Fl. Tert. Helv.," i, p. 102, pl. xlvii, figs. 1–6; Ett., "Fl. v. Bilin," p. 29, pl. vii, figs. 1, 2.

Stems slender, branching, geniculate-flexuous; leaves narrowly linear, acuminate, fasciculate, sessile; fruits round or broadly oval-apiculate, 1 millimeter in diameter.

Though the specimens merely represent the upper part of a stem the characters of the leaves and the fructification refer the plant to Heer's species. The fruits are slightly smaller, however, rather round than ovate or exactly like those represented by the author, pl. xlvii, fig. 5*c*.

Hab.—Florissant. No. 69 of Lacoe Collection.

NAJADOPSIS, Heer.

Najadopsis rugulosa, sp. nov.

Plate XXIII, Fig. 7.

Stem dichotomous from inflated apicial innovations; segments flat, dichotomous, linear, acuminate, decurrent to the main stem; surface merely irregular and minutely wrinkled lengthwise, without trace of medial nerves.

The substance of this plant is somewhat thick; the leaves or segments seem to have been originally cylindrical, though quite flat upon the stone, by compression? All that can be seen of the plant is figured. It has an

evident relation to *N. dichotoma*, Heer, "Fl. Tert. Helv.," i, p. 104, pl. xlviii, figs. 1–6. Not only the dichotomous disposition of the segments is analogous, but in fig. 1 of Heer the primary division appears as from an obscure innovation, while the top of the main stem seems to be inflated by the position of apparently fasciculate segments as they are in the middle of fig. 7 of our plate. The size of the European plant is smaller in all its parts.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

MUSACEÆ.

MUSOPHYLLUM, Goepp.

Musophyllum complicatum, Lesqx.

"U. S. Geol. Rep.," vii, p. 96, pl. xv, figs. 1, 6.

The station of the bed of coal and shale where this plant was found in great profusion, with remains of *Sapindus obtusifolius*, appears rather referable to the Green River Group than to the Miocene of Carbon from the presence of this last species, which has been found also at Florissant.

AROIDEÆ.

ACORUS, Linn.

Acorus brachystachys, Heer.

"U. S. Geol. Rep.," vii, p. 105, pl. xiv, fig. 16.

LEMNACEÆ.

LEMNA, Linn.

Lemna penicillata, sp. nov.

Plate XXIII, Fig. 8.

Leaves small, round in outline, irregularly crenulate on the borders; surface rugose; rootlets numerous, in fascicles.

The leaves, 3 to 4 millimeters in diameter, are rugose on the surface and do not show any trace of nerves; they appear to have been fleshy, but they are quite flattened into thin flakes on soft shales.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

PALMÆ.

FLABELLARIA, Schp.

Flabellaria Florissanti, sp. nov.

Plate XXIV, Figs. 1-2*a*.

Fronds large; rays diverging all around from the top of the nearly flat not keeled long rachis; rays large, very numerous, acutely keeled; primary nerves distinct; close intermediate veinlets, 3, 4.

This species has some degree of likeness to *Flabellaria eocenica*, Lesqx., "U. S. Geol. Rep.," vii, p. 3, pl. xiii, figs. 1–3. The rachis is not carinate but merely indistinctly lineate lengthwise, and the top of the rachis on one side of the leaf is also nearly truncate. The nerves are less distant and the intermediate veins less numerous. It is still more intimately related to *Flabellaria Lamanonis*, Brgt., and perhaps identical with it as figured in Sap., "Ét.," i, p. 70, pl. iv, fig. 5,—at least the number of primary nerves in each division of the rays and that of the intermediate veins are about the same. The lateral rays are more sharply keeled in the American form and also more open, the lateral ones being at right angles to the more distinctly truncate top of the petiole.

Hab.—Randolph Co., Colorado. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Apparently not Florissant

PALMOCARPON.

Palmocarpon? globosum, sp. nov.

Plate XXIV, Fig. 3.

Fruit large, globose, striate lengthwise.

The fruit is exactly globose, 18 millimeters in diameter; the testa appears to have been woody, though the fruit is flattened. This fruit has not been found in connection with the palm-leaf described above, but at a different locality, and therefore its reference to Palms is not positive. It resembles *Carpites lineatus*, Newby., as figured, pl. lx, fig. 1, "U. S. Geol. Rep.," vii, a species abundantly found at Evanston, where no remains of Palms have been discovered.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

DICOTYLEDONES.

MYRICACEÆ.

MYRICA.

"U. S. Geol. Rep.," vii, p. 126.

§ 1. Leaves dentate, serrate or undulate.

Myrica Copeana, Lesqx.

Ibid., p. 131, pl. xvii, fig. 5.

Myrica obscura, sp. nov.

Plate XXXII, Figs. 8–10.

Leaves linear-lanceolate, coarsely serrate, rounded in narrowing to the petiole, unequilateral at base; nervation obsolete.

This form is related by its shape and the teeth of the borders to *M. Banksiæfolia*, Ung., as figured by Heer, "Fl. Tert. Helv.," pl. c, figs. 3–10, differing merely by the more rounded and unequilateral base of the leaves and the total disappearance of lateral nerves by immersion into a thick carbonaceous coating. However, fig 6 of Heer represents two leaves without traces of lateral nerves, and fig. 8 has the base somewhat rounded and unequilateral, though not quite as distinctly as in the American form. The pedicel of this last figure is also slender, of the same length as in fig. 10 of our plate. The leaves are on an average a little smaller than those of *M. Banksiæfolia*, 7 to 9 centimeters long and 1 to 2½ centimeters broad above the base; the teeth are generally sharp, slightly inclined upward.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Myrica Ludwigii, Schp.

"U. S. Geol. Rep.," vii, p. 133, pl. lxv, fig. 9.

Myrica acuminata, Ung.

Ibid., p. 130, pl. xvii, figs. 1–4.

Myrica rigida, sp. nov.

Plate XXV, Figs. 3, 4.

Leaves thick, rigid, subcoriaceous, lanceolate-acuminate, serrate, rounded and unequilateral at base, short petioled; medial nerve thin, straight, the lateral craspedodrome.

This species differs from the preceding by the distinctly lanceolate form of the leaves equally and gradually narrowing from the rounded base to the apex, by the short petiole, the distinct lateral veins and the

blunt teeth of the borders. The leaves are also proportionally shorter, 5 to 7 centimeters long and 1 to 2 centimeters broad near the base. It is intermediate between the preceding and the following species.

Hab.—With the preceding.

Myrica Zachariensis, Sap.

Plate XXV, Fig. 5; XLV[a], Figs. 6–9.

Leaves very variable in size and shape, lanceolate and linear, narrowed and more or less decurrent to the petiole; medial nerve thick; lateral nerves open, curved in passing to the borders and along them; teeth entered by branchlets.

This species, as figured by Saporta, "Ét.," i, ii, p. 201, fig. 5, is represented in pl. xxv, fig. 5, and xlv[a], fig. 7. It is the variety *b. elongata.* The variety *c. angustifolia*, Sap., *loc. cit.*, fig. 1, has the character of pl. xlv[a], figs. 6–8, while fig. 9 of the same plate is exactly like a counterpart of fig. 10*b.*, Sap., "Ét.," ii, pl. 5, which is the variety *minuta* of this species. It differs from the two preceding species by the gradual narrowing of the base to the petiole, the border base being decurrent to it and bordering it to the point of attachment.

Hab.—Florissant. Specimens, pl. xlv[a], figs. 6–9, are from Alkali Station.

Myrica polymorpha, Schp.

Plate XXV, Figs. 1, 2.

Leaves thickish, membranaceous or subcoriaceous, long-lanceolate or linear-lanceolate acuminate, narrowed at base to a short petiole, serrate or denticulate; primary nerves thick at base, the lateral more or less oblique, slightly curving in passing to the borders.

This species is described by Saporta as *Myricophyllum Zachariense*, "Ét.," i, ii, p. 220, pl. viii, fig. 2, with varieties *spinulosa* and *laciniata*, according to the more or less deep and acute teeth of the borders. Our plate represents the normal form. The leaves are long comparatively to their width—6 to 8 centimeters long, 5 to 6 millimeters broad. The species is, like the preceding, very polymorphous. The author compares it to the living *Myrica Æthiopica*, Linn., especially as to its nervation.

Hab.—Very common at Florissant.

Myrica callicomæfolia, sp. nov.

Plate XXVI, Figs. 5–14.

Callicoma microphylla, Ett., "U. S. Geol. Rep.," vii, p. 246, pl. xliii, figs. 2–4.

This species is evidently a *Myrica.* Better specimens show that the

fragment which I considered as a compound leaf is a small branch with alternate leaves. The reference to *Callicoma* is not possible, as in this genus the divisions are opposite. Except from what is seen in the branch, fig. 5, whose divisions are alternate, distant, parallel, as well as the leaves, there is nothing to modify in the description of this species in vol. vii, *loc. cit.* The teeth are not always sharply acute, but more or less so, always inclined upward.

The species is closely related in the nervation to *M. Zachariensis*, var. *minuta*, Sap., *loc. cit.*, but differs evidently in the more rounded and unequilateral base of the leaves.

Hab.—Most abundant at Florissant, also at Elko Station, Utah.

Myrica fallax, sp. nov.

Plate XXXII, Figs. 11-16.

Very similar in its characters to the preceding species and perhaps a variety of it. It merely differs in the teeth being sharply acuminate or subspiniform, the lateral nerves less curved in passing toward the borders, the base of the leaves not as distinctly unequilateral. It is distantly related to *M. acuminata*, Ung.

Hab —Florissant. Not rare.

Myrica Scottii, sp. nov.

Plate XXXII, Figs. 17, 18.

Leaves coriaceous, long and narrow, linear-acuminate, narrowly cuneate to the petiole, sharply dentate; lateral veins more or less oblique and curved.

By the leaves, 6 to 9 centimeters long, 6 to 10 millimeters broad, with sharply spinescent teeth turned upward, the species is related to *M. Banksiæfolia*, Ung., and *M. obscura*, described above. It differs from both in the sharply dentate borders of the leaves, the lateral nerves being distinct and more acutely diverging.

Hab.—Florissant. Princeton Museum.

Myrica amygdalina, Sap.

Plate XXVI, figs. 1-4.

Sap., "Et.," iii, ii, p. 21, pl. 1, figs. 8-10.

Leaves submembranaceous, oblong-lanceolate, obtuse or apiculate, narrowed to a short petiole, denticulate or subentire; secondary nerves numerous, at an acute angle of divergence, obliquely branching and reticulate.

The leaves are small, 2½ to 5½ centimeters long, enlarged toward the upper part; the areolation is distinct, formed by nervilles crossing the oblique divisions of the lateral nerves at right angles.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Myrica nigricans, Lesqx.

"U. S. Geol. Rep.," vii, p. 132, pl. xvii, figs. 9–12.

Myrica Bolanderi, Lesqx.

Ibid., p. 133, pl. xvii, fig. 17.

Myrica undulata, Lesqx.

Ibid., p. 131, pl. xvii, fig. 5.

Leaves lobate; lobes irregular, often serrate.

§ 2. Leaves pinnately lobed (*Comptonia*).

Myrica partita, Lesqx.

Ibid., p. 134, pl. xvii, fig. 14.

Myrica diversifolia, sp. nov.

Plate XXV, Figs. 6–15.

Leaves membranaceous, short-petioled, either longer, deeply lobate and lanceolate, or shorter, broadly ovate, diversely tri-quadri-lobate; lobes dentate; primary nerves narrow, the secondary open, curved in passing to the points of the lobes or of the teeth, branching; tertiary nerves in the direction of the sinuses, forking under them, each branch following the borders. Seeds small, oval-acute.

At first it is difficult to see that these leaves are referable to the genus *Myrica* and that they all represent the same species. In comparing, however, fig. 6 to *Myrica Græffii*, Heer, "Fl. Tert. Helv.," iii, p. 176, pl. cl, figs. 19, 20, the character of the nervation, the form of the leaves, the dentate lobes will be found much alike. The species are far different but the type is the same. The same degree of affinity is remarked between figs. 11–13 of our plate with *Myrica latiloba*, Heer, figs. 12–15 of the same plate; there is also a marked degree of relationship between the leaves I refer to this species and *Comptonia laciniata*, Ung., "Fl. von Sotzka," p. 31, pl. viii, fig. 2.

Comparing now with one another the fragments which represent this species, we see in fig. 8 the same characters exactly as in fig. 6, merely modified by the shortening of the leaves and of their lobes. Fig. 11 represents an intermediate form, and with its deep-cut lobes fig. 13 is like an original representation of fig. 11. Indeed, considering the characters of

these leaves with the more or less broadly cuneate base decurrent to the short petiole, their sharply dentate lobes, the membranaceous substance, the nervation. I am not able to find any difference to separate them into two or more species, and still less to refer them to a different genus. Some of the leaves (fig. 14 especially) have some of the characters of *Cratægus*, but the nervation recalls them to *Myrica*. The small seed, fig. 15, though a seed of *Myrica*, is not positively referable to this species.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Myrica latiloba, Heer, var. acutiloba.

"U. S. Geol. Rep.," vii, p. 134, pl. xvii, fig. 13.

§ 3. Leaves pinnately lobed (*Comptonia*).

The leaf mentioned with the description of this species as being identical in character with it and obtained from the Miocene of Oregon is figured, pl. l, fig. 10, and described with Miocene plants.

Myrica Brongniarti?, Ett.

"U. S. Geol. Rep.," vii, p. 135, pl. xvii, fig. 15.

Myrica Alkalina, sp. nov.

Plate XLV*a*, Figs. 10–15.

Leaves short, trilobate and obtusely dentate from a cuneate base, or lanceolate, rounded and narrowed to the base, pinnately, obtusely or acutely dentate.

The species represented by a large number of fragmentary leaves, mixed upon the same specimens, present two forms, rather marked varieties, especially differing by acute or obtuse lobes or teeth. The leaves are subcoriaceous or membranaceous, somewhat large, 3 to 8 centimeters long, 2½ to 3 centimeters broad, either lobate with narrow cuneate base, or pinnately deeply dentate, more or less obtusely cuneate at base. The medial nerve is thick; the lateral nerves, at a broad angle of divergence, much curved in passing up to the points of the lobes, are generally separated by parallel shorter tertiary veins, anastomosing with oblique nervilles or branchlets derived from the secondary nerves.

The species is comparable to both *Myrica Vindobonensis*, Ett., in Heer, "Fl. Tert. Helv.." p. 34, pl. lxx, figs. 5, 6, and *M. Ungeri*, Heer, *l. c.*, p. 35, pl. lxx, figs. 7, 8, differing from both by shorter comparatively broader leaves, more equally dentate-lobed.

As represented upon the plates, the leaves would seem to be referable to two different species. The fragments, however, are so well mixed together that sometimes one leaf appears acutely dentate on one side and obtusely so on the other.

Hab.—Alkali Station, Wyoming. Professor *Scudder*.

Myrica insignis, Lesqx.

"U. S. Geol. Rep.," vii, p. 135, pl. lxv, figs. 7, 8.

This species has a degree of relationship to the preceding.

BETULACEÆ.

BETULA, Linn.

"U. S. Geol. Rep.," vii, p. 137.

Betula Florissanti, sp. nov.

Plate XXVII, Fig. 11.

Leaves small, lanceolate-acuminate, unequilateral at the cuneate base, borders doubly serrate; medial nerve thin; secondary nerves generally opposite, curved in passing to the borders, branching, entering the teeth like the branches and united by nervilles.

The leaf, 5½ centimeters long, 1½ broad, appears unequilateral at the narrowed base. The primary and secondary teeth are small, acute, and turned upward.

Hab.—Florissant. Princeton Museum.

Betula truncata, sp. nov.

Plate XXVIII, Figs. 7, 8.

Leaves short and short-petioled, ovate-lanceolate, truncate or rounded at base, simply dentate; lateral veins at a broad angle of divergence, numerous, parallel, the lower opposite.

The leaves, 3 to 4 centimeters long, 2 centimeters broad, equally dentate from near the base, have the secondary nerves at an angle of divergence of 60°, generally branching. The relation of this species is to *Betula crenata*, Ung., "Schoss. Fl.," p. 11, pl. iii, figs. 7, 8. The lateral nerves are more open, more numerous, and less curved in the American species.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden*.

ALNUS, Tourn.

"U. S. Geol. Rep.," vii, p. 139.

Alnus Kefersteinii, Goepp.

Ibid., p. 140, pl. xviii, figs. 6–8; lxiv, fig. 11.

Alnus inæquilateralis, Lesqx.

Ibid., p. 141, pl. lxii, figs. 1–4.

Alnus cordata, sp. nov.

Leaf cordate at base, pyramidal and acuminate, doubly serrate on the borders, long-petioled; primary nerves thick, the lateral opposite, parallel, 8 pairs, at acute angles of divergence, curving in passing to the borders, craspedodrome.

The leaf is 6 centimeters long, has a thick petiole 3 centimeters long, is largest near the cordate base (3 centimeters), and hence tapering to an acute point and dentate all around. The leaf resembles *Alnus diluviana*, Ung., "Iconogr.," pl. xvi, fig. 16, but is more acutely tapering to the point, and the lateral nerves, at a more acute angle of divergence, are more curved.

Hab.—Florissant. Lacoe's Cabinet, No. 83.

Flowers of *Alnus*, pl. xxxix, fig. 3, are also found at Florissant, but are not identifiable in species.

CUPULIFERÆ.

OSTRYA, Michx.

"U. S. Geol. Rep.," vii, p. 142.

Ostrya betuloides, sp. nov.

Leaves small, broadly ovate, acute, rounded to the equilateral base; borders dentate; lateral nerves close, at a broad angle of divergence.

The leaf is of the same size and shape as that of *Ostrya Atlantidis*, Sap., "Ét.," ii, 2, p. 254, pl. vi, fig. 4, differing in the simple teeth of the borders, which give to the leaf the appearance of a *Betula;* but there is with the same specimen a fragment of an involucre of *Ostrya*, similar in size to that of Sap., fig. 11, *l. c.*, and still more to *Ostrya tenerrima*, Sap., "Ét.," i, 2, p. 49, pl. v, fig. 6, differing only from the last by its larger size (2 centimeters long). Possibly this involucre is referable to the same species as the leaf. It is the only one seen, as yet, from this formation.

Hab.—Florissant. Lacoe's Cabinet, Nos. 26 and 29.

CARPINUS, Linn.

"U. S. Geol. Rep.," vii, p. 142.

Carpinus grandis, Ung.

Ibid., p. 143, pl. xix, fig. 9; lxiv, figs. 8–10.

Carpinus attenuata, sp. nov.

Plate XXVII, Fig. 10.

Leaf large, narrowed downward from the middle and upward to an acuminate point, slightly unequilateral at base; borders doubly dentate; lateral nerves oblique, straight, or slightly curved in passing up to the borders, branching near the borders, entering the primary teeth by their ends and the intermediate ones by their branches.

This leaf, 11 centimeters long, 5½ centimeters broad in the middle, its widest part, is equally narrowed upward and downward, with borders cut by large teeth entered by the secondary nerves, and generally two smaller ones intermediate or on the lower side of the primary teeth. The leaf appears to have been somewhat unequal at the base, but the broader side is lacerated; the veins are, however, equally oblique at the base and not more open on one side. The leaf closely resembles *Carpinus alnifolia*, Goepp., "Schoss. Fl.," p. 19, pl. iv, fig. 11, merely differing by the border teeth being a little larger, and by the more distinctly narrowed and elongated base. Schimper unites this last species to *C. ostryoides* of Goepp., *l. c.*, figs. 7–10. Fig. 7 represents a much smaller leaf, but it is narrowed to the base nearly in the same degree as in that of Florissant.

Hab.—Florissant. Princeton Museum, No. 258.

Carpinus fraterna, sp. nov.

Plate XXVII, Figs, 12–14.

Leaves small, lanceolate, rounded to the short petiole; borders minutely, sharply, doubly serrate; lateral nerves close, numerous, oblique and straight to the borders, branching near the borders.

The species is of the same type as *Carpinus Americana*, Linn., some of its varieties having leaves as small and of the same pattern. They are generally more coarsely or distinctly serrate than in the fossil species; the leaves are also generally larger.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

FAGUS, Tournf.

"U. S. Geol. Rep," vii, p. 145.

Fagus Feroniæ, Ung.

Ibid., p. 146, pl. xix, figs. 1-3.

QUERCUS, Linn.

Ibid., p. 147.

§ 1. Leaves dentate.

Quercus Haidingeri, Ett.

Ibid., p. 156, pl. xx, figs. 9, 10.

Quercus Mediterranea, Ung.

Plate XXVIII, Fig. 9.

Ung., "Chlor. Protog.," p. 114, pl. xxxii, figs. 5–9; "Iconogr.," pl. xviii, figs. 1–6; Heer, "Fl. Tert. Helv.," ii, p. 52, pl. lxxiii, figs. 13, 15, 17, 18; Ung., "Foss. Fl. v. Kumi," p. 28, pl. vi, figs. 1–22; Gaud., "Contr.," ii, p. 46, pl. iv, figs. 16–19.

Leaves coriaceous, obovate, abruptly acuminate, narrowed toward the base and abruptly rounded to it, deeply dentate; secondary nerves simple, craspedodrome, about 9 pairs; nervilles strong, at right angles to the secondary nerves, simple or more generally anastomosing in the middle.

Except that the teeth of the borders are slightly more acute and turned upward in the European species, I see no difference sufficiently marked to authorize a separation of this leaf into a new species. The leaf, fig. 3 of Ung., *loc. cit.*, is like a counterpart of our fig. 9, and in other leaves figured by different authors the teeth of the borders are not sharply acute, but sometimes obtuse and nearly effaced. It is the case in Ung., "Chlor.," pl. xxxii, fig. 5; in Heer, "Fl. Tert. Helv.," pl. lxxvi, figs. 13–15. The nervilles are distinctly seen in figs. 3–4 given of this species in Ung., "Fl. v. Kumi," pl. vi, where twenty leaves of this species are represented. All these, however, have the border teeth more acute and proportionally smaller than in fig. 9 of our plate.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Quercus serra, Ung.

"Chloris Protog.," p. 109, pl. xxx, figs. 5–7.

Leaves petioled, subcoriaceous, elliptical, pointed or obtuse, serrate-dentate on the borders; teeth equal, with callous points.

A single leaf, 4 centimeters long without the petiole, 2½ centimeters broad, remarkably similar to fig. 7 of Ung., *loc. cit.*, oval or obtusely ovate.

with a short thick petiole. The lateral nerves are much curved in passing to the borders, close, craspedodrome.

Hab.—Florissant. Lacoe's Collection, No. 64.

Quercus Drymeja, Ung.

Plate XXVIII, Fig. 12.

"U. S. Geol. Rep.," p. 157, pl. xix, fig. 14.

Among the numerous figures given of this species this leaf is especially comparable to Ung., "Chlor. Prot.," pl. xxxii, fig. 1, and to "Fl. of Sotzka," pl. ix, fig. 1. The lateral veins are mostly craspedodrome, the lower pairs entering the teeth by an anastomosing veinlet. The species is very common in the Miocene of Europe. The reference of the fragment of leaf described, vol. vii, *loc. cit.*, is not certain.

Hab.—Randolph Co., Wyoming. U. S. Geol. Expl. Dr. *F. V. Hayden*

Quercus Osbornii, sp. nov.

Plate XXXVIII, Fig. 17.

Leaf small, obovate, abruptly long-acuminate, dentate from under the acumen to the middle; medial nerve thin; secondary nerves oblique, alternate, parallel, camptodrome.

This fine leaf, about 7 centimeters long, is gradually narrowed from above the middle to the base (broken), rounded in the upper part, there cut by three or four large teeth, and then abruptly long-acuminate. The lateral nerves diverging 30° to 40°, curve in passing up to the borders, which they follow in festoons, entering the teeth by anastomosing branchlets. I do not find any other species comparable to this but *Quercus Tephrodes*, Ung., as described in "Sieber, Nord-Böhm. Braun-Kohl.," pl. iii, fig. 17. *Quercus hexagona*, Lesqx., "U. S. Geol. Rep.," vi, pl. v, fig. 8, is also of the same type.

Hab.—Florissant. Princeton Collection, No. 684.

Quercus pyrifolia, sp. nov.

Plate XXVIII, Fig. 14.

Leaves rather thin, oval, short-acuminate, rounded in narrowing to a long petiole; borders irregularly obscurely serrate; secondary nerves curving in passing to the borders, camptodrome, crossed by nervilles at right angles.

The petiole of the leaf is 1½ centimeters long, and the leaf without it

is 5 centimeters long and nearly 3 centimeters broad in the middle. It is broken at the apex, but appears as tapering to a short acumen. The lateral nerves, 5 or 6 pairs, at an angle of 40°, are thin, flexuous, camptodrome, following the borders and joined to some of the teeth by anastomosing veinlets; nervilles flexuous or transversely curved.

Species related to *Quercus larguensis*, Sap., "Ét.," iii, 1, p. 67, pl. 5, fig. 1, which has the same form, the borders irregularly cut-dentate.

Hab.—Florissant. Princeton Museum, No. 797.

Quercus castaneopsis, sp. nov.

Plate XXVIII, Fig. 10.

Leaves large, lanceolate, gradually acuminate, regularly distantly dentate; lateral nerves parallel, at an open angle of divergence, the lower joining the medial nerves at right angles, all camptodrome, curving in passing to the borders, following them and entering the short teeth by oblique nervilles; areolation of minute polygonal meshes.

This leaf may represent a *Castaneopsis*. I do not know of any fossil species to which it may be compared.

Hab.—Randolph Co., Wyoming. U. S. Geol. Expl. Dr. *F. V. Hayden.*

§ 2. Leaves entire.

Quercus elæna, Ung.

Plate XXVIII, Figs. 11, 13.

Ung., "Chlor. Protog.," p. 112, pl. xxxi, fig. 4; Heer, "Fl. Tert. Helv.," ii, p. 47, pl. lxxiv, figs. 11–14; lxxv, fig. 1; iii, p. 173, pl. cli, figs. 1–3; Sap., "Ét.," ii, p. 85, pl. iii, fig. 11; iii, p. 65, pl. ii, figs, 5–9; v, fig. 2.

Leaves coriaceous, short-petioled, oblong-lanceolate; borders entire, revolute or reflexed; lateral nerves camptodrome.

The leaves vary from 5 to 7 centimeters long and from 1 to 1½ centimeter broad. Those figured here especially resemble the figures in Sap., *loc. cit.*, pl. ii, figs. 5–10.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Quercus neriifolia, Al. Br.

Plate XXXI, Fig. 12.

"U. S. Geol. Rep.," vii, p. 150, pl. xix, figs. 4, 5.

I refer with doubt to this species a subcoriaceous polished leaf 10 centimeters long, 22 millimeters broad in the middle, whose borders are

not entire but distantly dentate, and the base slightly decurrent to a thick short petiole. In the European species the leaves are mostly entire, but sometimes also denticulate in the upper part, and the base of the leaf is not as decurrent, while the petiole, generally thick, is a little longer. The nervation is as represented in Heer, "Fl. Tert. Helv.," ii, pl. lxxiv, fig. 4.

Hab.—Randolph Co., Wyoming. U. S. Geol. Expl. Dr. *F. V. Hayden.*

CASTANEA, Linn.

Castanea intermedia, Lesqx.

"U. S. Geol. Rep.," vii, p. 164, pl. xxi, fig. 7.

SALICINEÆ.

SALIX, Linn.

Salix amygdalæfolia, sp. nov.

Plate XXXI, Figs. 1, 2.

"U. S. Geol. Rep.," p. 165.

Leaves narrowly lanceolate, tapering to a blunt acumen, rounded in narrowing to the petiole, serrulate; lateral nerves at an acute angle of divergence.

The leaves, 6 to 7 centimeters long, 12 to 15 millimeters broad, with a slender petiole 2 centimeters long, may seem to represent a variety of *S. varians*, Goepp., so common in the European Miocene. But they are generally much smaller, more narrowly lanceolate; the secondary nerves, especially the basilar ones, at a more acute angle of divergence; the borders more distinctly serrate-crenate. The form of the leaves is the same as in *S. lavateri*, Al. Br., but the leaves of this last species are much longer.

Hab.—Florissant. Seen in the different collections from that locality.

Salix Libbeyi, sp. nov.

Plate XXXI, Fig. 3.

Leaves large, thick, oblong, enlarged upward, rapidly narrowed to the point, tapering to the base, very entire.

The nearest relation of this species is *S. abbreviata*, Goepp., "Schoss. Fl.," p. 25, pl. xvii, figs. 4–11, especially like fig. 7; but the American leaf is twice as large, 8 centimeters long, 2½ broad in the upper part, narrowed to the base, which is not rounded, and more enlarged upward.

Hab.—Florissant. Princeton Museum, No. 780.

Salix media, Heer.

"U. S. Geol. Rep.," vii, p. 168, pl. xxii, fig. 3.

Salix angusta, Al. Br.

Ibid., p. 168, pl. xxii, figs. 4, 5.

Salix elongata, O. Web.

Ibid., p. 169, pl. xxii, figs. 6, 7.

POPULUS, Linn.

Ibid., vii, p. 169.

Populus Heerii, Sap.

Plate XXX, Figs. 1–8; XXXI, Fig. 11.

Sap., "Ét.," i, p. 87, pl. vii, fig. 3.

Leaves long-petioled, ovate, long-lanceolate, acuminate, obtusely serrate; primary nerves thick; lower secondary nerves at a more acute angle of divergence and ascending higher along the borders, the others curving in passing to the borders and reticulate in following them.

The leaves are extremely variable in size, some, as shown in fig. 5, being 20 to 30 centimeters long and 10 to 12 centimeters broad below the middle; others, as in fig. 2, scarcely 5 centimeters long and 2 broad; others still, as in fig. 11 of pl. xxxi, being narrow comparatively to their length, 10 centimeters long, 2 centimeters broad, thus resembling leaves of willows. That all these leaves represent the same species is evident enough. Besides the essential characters in common, they have the same somewhat thick consistence, and are all colored reddish-yellow even upon shales where all the fragments of other plants are colored black.

Saporta, who has described a fruit of *Populus* found upon the same slate as his leaf, compares it to that of *P. Euphratica*, Oliv., and the leaves to *P. laurifolia*, Ledeb. We have still living in the Rocky Mountains of Colorado and Utah a species, *P. angustifolia*, James, considered by some authors as a variety of *P. balsamifera*, Linn., which represents the fossil species in the different forms and size of its leaves. Those of the living species vary from 5 to 24 centimeters long and 2 to 10 centimeters broad, being either attenuated or broadly cordate at base, according to their width.

Hab.—Florissant. Found in all the collections.

Populus balsamoides? Goepp., var. latifolia.

Plate XXXI, Fig. 4.

Goepp.. "Fl. v. Schoss.," p. 23, pl. xv, figs. 5, 6; Heer, "Fl. Tert. Helv.," ii, p. 18, pl. lix; lx, figs 1–3.

Leaf very large, apparently broader than long, cordate-ovate; borders undulate, crenate; primary nerves thick; lateral nerves thin, much curved to and along the borders; the lower pairs much branched, the other simple.

This leaf, about 12 centimeters long and 14 broad toward the base, seems to represent a different species from those figured under this name by European authors. It is broader than long, while the leaves of *P. balsamoides* are, according to Heer, always longer than broad; it is deeply cordate at base, and the lateral veins, without any basilar veinlets, are comparatively very thin, much curved and all alike; the borders are merely crenulate, even obscurely so, while they are more or less deeply serrate in the normal form of *P. balsamoides*. Fig. 7, pl. lix, of Heer, *l. c.*, represents, however, a leaf with borders obscurely dentate and nearly as large as that of fig 4, cordate at base; and fig. 1 of pl. lx of Heer shows the lateral nerves of the same character as they are in the American leaf. There is between the fossil leaves a difference as marked as between those of the living *Populus balsamifera*, Linn., and *P. candicans*, Ait. This last, though with broader and more or less heart-shaped leaves, is considered a mere local variety of the first.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Actually Green River

Populus Zaddachi, Heer.

Plate XXXI, Fig. 8.

"U. S. Geol. Rep.," vii, p. 176, pl. xxii, fig. 13.

The figured leaf is one of the smallest of this species, and besides differs from the normal form in some points. The secondary nerves descend a little lower; the border teeth, though obtuse and turned upward, have not at the apex the small glands which are generally seen in the small leaves of this species. As these glands may have been destroyed by maceration, as is often the case, and as this species is very common in the North American Tertiary, I consider this leaf as a mere variety.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Populus oxyphylla, Sap.

Plate XXXVIII, Figs. 9–11.

Sap., "Ét," iii, 1, p. 73, pl. vii, fig. 1.

Leaves of small size, long petiolate, deltoid, short-acuminate, rounded to the base, denticulate; secondary nerves variable in distance, the lower longer, branching outside.

The leaves vary from 2½ to 4 centimeters long and from 1½ to 2½ centimeters broad below the middle, from which part they taper upward to a point or short acumen; the petiole is 2 to 3 centimeters long. The author describes and figures the lateral nerves as flexuous, a character which is not seen on the leaves which I refer to this species. The nerves are, however, camptodrome, the teeth being entered, as seen in fig. 11, the best preserved leaf, by short veinlets anastomosing to the curves of the lateral nerves. In this leaf also the nervilles and their mode of ramification in forming large primary irregularly hexagonal meshes are of the same type as in the figure of Saporta.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.* One specimen, No. 54, not figured here, is in the collection of Mr. Lacoe.

Populus Richardsoni, Heer.

"U. S. Geol. Rep.," vii, p. 177, pl. xxii, figs. 10–12.

Populus arctica, Heer.

Ibid., p. 178, pl. xxiii, figs. 1–6.

BALSAMIFLUÆ.

LIQUIDAMBAR, Linn.

Ibid., vii, p. 186.

Liquidambar Europæum, Al. Br.

Plate XXXII, Fig. 1.

Al. Braun, "Buckl. Geol.," p. 112; Ung., "Chlor. Protog.," p. 120, pl. xxx, figs. 1-5; Goepp., "Tert. Fl. v. Schoss.," p. 22, pl. xii, figs. 6, 7; Heer, "Fl. Tert. Helv.," ii, p. 6, pl. li, lii, figs. 1–3; Ludw., "Palæontog.," viii, p. 89, pl. xxv, figs. 1–4; Gaud., "Contrib.," iv, p. 19, pl. iv, figs. 5–7.

Leaves long-petioled, palmately 3 to 5-lobed; lobes more or less distinctly glandulose, serrulate, lanceolate-acuminate.

In the leaf figured as referable to this species the borders appear nearly entire or merely undulate-crenate; but it is the only difference from the normal form which is very common in the Miocene of Europe.

The leaves preserved flattened on some of the thin sandy shales of Florissant very often have the borders erased and the small teeth therefore often destroyed. The medial lobe of the figure has the teeth quite as distinct as in some of the figures of European authors, still more so than in fig. 5 of Gaudin, *l. c.*

Hab.—Randolph Co., Wyoming. U. S. Geol. Expl. Dr. *F. V. Hayden.*

URTICINEÆ.

ULMACEÆ.

ULMUS, Linn.

"U. S. Geol. Rep.," vii, p. 187.

Ulmus tenuinervis, Lesqx.

Ibid., p. 188, pl. xxvi, figs. 1, 3.

Ulmus Hilliæ, sp. nov.

Plate XXVIII, Figs. 1, 3.

Leaves narrow, lanceolate-acuminate, very unequilateral at base, simply or doubly-serrate; lateral veins curved in passing to the borders, craspedodrome.

The leaves are small, 5 to 9 centimeters long, 1½ to 2½ centimeters broad, short-petioled, thickish; the base is narrowed on one side inrounding to the petiole, straight on the other; the teeth of the borders are large, slightly turned up, not very sharp; the areolation is quite distinct in small irregularly quadrangular meshes, formed by subdivisions of nervilles mostly at right angles.

Hab.—Florissant. Mrs. *Hill*, who has widely collected and distributed the specimens of fossil plants of that locality.

Ulmus Brownellii, sp. nov.

Plate XXVIII, Figs. 2, 4.

Leaves narrow, oblong-lanceolate, unequal at base, simply obtusely dentate; lateral nerves simple, parallel, the lower open; nervilles irregularly branching and anastomosing; areolation polygonal, loose.

This species resembles the preceding, differing by the simple teeth and nerves; the areoles, much larger, formed by irregularly divided nervilles.

Hab.—Florissant. U. S. Geol. Expl.; White River. *W. A. Brownell.*

Ulmus Braunii, Heer.

Plate XXVII, Figs. 1–4, 8.

Heer, "Fl. Tert. Helv.," ii, p. 59, pl. lxxix, figs. 14–21; iii, p. 181, pl. cli, fig. 31; Gaud., "Contrib.," ii, p. 47, pl. iii, figs. 3–9; Ludw., "Palæontog.," viii, p. 105, pl. xxxviii, figs. 5–8; Ett., "Fl. v. Bil.," p. 64, pl. xviii, figs. 23–26.

Leaves short-petioled, very unequilateral, round or cordate at base, elliptical or ovate-lanceolate, acute or acuminate, doubly or simply coarsely dentate; teeth conical, turned up; lateral veins open, at right angles toward the base, 12–18 pairs; fruit petiolate, broadly-winged; wings lateral.

This species is very variable in the form of the leaves and the more or less acute teeth of the borders. The leaves, 4½ to 12 centimeters long, 2½ to 4½ centimeters broad, are comparatively broader and shorter and more unequilateral and difform than those of the preceding species. It is very common in the European Miocene and is also abundantly found at Florissant, where the fruits also are not rare. But these fruits, always found ripe, do not agree with the figures given by Heer, *loc. cit.*, pl. cli, fig. 31; they are rather like those of *U. Brownii*, or *U. longifolia*, Ung., as figured in "Bil. Fl.," pl. xviii, figs. 4, 5, 8. The specific relation of the seeds of *Ulmus* described by European authors is hypothetical, as well as that of those I have figured.

Hab.—Florissant. Not rare; especially in Princeton Collection.

PLANERA, Gmel.

"U. S. Geol. Rep.," vii, p. 189.

Planera longifolia, Lesqx.

Plate XXIX, Figs. 1–13; XLIV, Fig. 10.

Lesqx., "U. S. Geol. Rep.," vii, p. 189, pl. xxvii, figs. 4–6.

Planera longifolia, var. myricæfolia.

Plate XXIX, Figs. 15–27.

From a comparison made in the examination of more than two thousand specimens, representing not merely the leaves figured but a large number of intermediate forms, I have been forced to admit that they all belong to the same species, and that though some of them are closely allied to the European *Planera Ungeri*, they constitute a different species. First examining the relation of all the leaves from No. 1, the normal type, to

No. 13, all have simple, more or less acute, more or less distant teeth; and the lateral veins all simple, straight, craspedodrome, vary in nothing but in their more or less acute angle of divergence according to the width of the leaves; the petiole is equally variable, from 5 to 10 millimeters long, and the leaves are sometimes nearly sessile, as in fig. 7. One of the leaves of fig. 1 has also the petiole very short. Comparing the different forms of figs. 14–27 we see the same essential characters preserved—that is, lateral veins straight, craspedodrome, at a more or less acute angle of divergence relatively to the width of the leaves, the teeth either sharply acute, even acuminate, or merely pointed, even obscurely so, as in figs. 25, 27. The petiole is generally of the same length, but some of the leaves (figs. 21, 26, 27) are narrowed to the base and nearly without petiole. If I add that all these leaves have the same consistence and black color upon the shale, that both forms are often found upon the same specimens, that it is often scarcely possible to say that a leaf is referable to the normal type or to the variety, it will be understood why I am unable to consider these leaves as representing different species or referable to two genera, though, comparing the extreme forms (figs. 1, 5, 6, to figs. 21, 24, 27), this separation seems indeed natural.

As for the identity of this species with *P. Ungeri*, it is disproved by the comparatively large and narrower leaves, the veins, exactly straight from the medial nerves to the point of the teeth, never curved, and the fruits which, as seen in comparing fig. 12 with fig. 1, pl. lxxx of Heer, "Fl. Tert. Helv.," are nearly twice as large in the American species. The difference in the characters of the leaves may be easily seen in comparing the figures of pl. xxix with that of *P. Ungeri*, quoted below.

Hab.—Florissant. Most abundant.

Planera Ungeri, Ett.

"U. S. Geol. Rep.," vii, p. 190, pl. xxvii, fig. 7.

CELTIDEÆ.

CELTIS, Tourn

"U. S. Geol. Rep.," vii, p. 191.

Celtis McCoshii, sp. nov.

Plate XXXVIII, Figs. 7, 8.

Leaves long-petioled, narrowly ovate, lanceolate-acuminate, more or less unequilateral at base; lower lateral nerves at a more acute angle of divergence, ascending higher across the borders, curved like the upper (4 to 6 pairs), all camptodrome, attached to the borders by anastomosing veinlets.

The leaves, 5 to 6½ centimeters long, 2 to 2½ centimeters broad below the middle, where they are widest, are not very but distinctly unequilateral at the rounded base, at least in fig. 7. By the form of the leaves the species is closely allied to *Celtis primigenia*, Sap., "Ét.," ii, 2, p. 263, pl. vi, fig. 7. The nervation and the denticulation of the leaves are of the same character. The leaves are also remarkably similar to those of *C. occidentalis*, Linn., var. *Texana*, a form whose leaves, nearly equilateral at base, are minutely serrate. The Texas leaves are subcordate at base or round, as in fig. 8.

Hab.—Florissant and Randolph Co., Wyoming. Princeton Collection, No. 794, U. S. Geol. Expl. Dr. *F. V. Hayden*.

MOREÆ.

FICUS, Tourn.

"U. S. Geol. Rep.," vii, p. 191.

Ficus lanceolata, Heer.

Ibid., p. 192, pl. xxviii, figs. 1, 5.

Ficus Jynx, Ung.

Ibid., p. 193, pl. xxviii, fig. 6.

Ficus multinervis, Heer.

Ibid., p. 194, pl. xxvii, figs. 7, 8.

Ficus arenacea, Lesqx.

Ibid., p. 195, pl. xxix, figs. 1–5.

Ficus Ungeri, Lesqx.

Plate XLIV, Figs. 1–3.

Ibid., p. 195, pl. xxx, fig. 3.

This species is finely represented by the three figures of our plate. They show not merely the variable size of the leaves, but their true shape and the short petiole abruptly thickened at base. The leaves, are oblong

or lingulate, rounded at the base and apparently at the apex also; they vary in size from 10 to 20 centimeters long and from 3½ to 6½ centimeters broad in the middle. Fig. 2 may represent a different species not merely on account of the different size, but from the presence of tertiary thinner and shorter veins intermediate to the secondary nerves.

Hab.—Alkali Station, Wyoming. Professor *Scudder;* Green River Station, U. S. Geol. Expl. Dr. *F. V. Hayden.*

Ficus Wyomingiana, Lesqx.

"U. S. Geol. Rep.," vii, p. 205, pl. xxxiv, fig. 3.

Ficus tenuinervis, sp. nov.

Plate XLIV, Fig. 4.

Leaf oblong or lanceolate, tripalmately nerved, rounded at base, entire.

A mere fragment, showing the lower part of a leaf whose lower lateral nerves are strongly branched downward and all (nerves and branches) camptodrome. The medial nerve is inflated at base. The fragment represents a *Ficus*, but the specific characters are not discernible.

Hab.—Alkali Station. Professor *Scudder.*

Ficus alkalina, sp. nov.

Plate XLIV, Figs. 7–9.

Leaves thin, variable in size, obovate or ovate-lanceolate, acuminate, obtusely serrulate, palmately trinerved; secondary nerves distinct, all camptodrome, alternate and parallel; nervilles oblique, simple or forking in the middle.

The leaves are fragmentary, variable in length from 6 to 10 centimeters, and proportionally broad. The nervation is that of a *Ficus;* the lower primary lateral nerves are thin, flexuous, ascending at a more acute angle of divergence. The upper are parallel, camptodrome, attached to the teeth by small anastomosing nervilles.

Hab.—Alkali Station. Professor *Scudder.*

SANTALEÆ.

SANTALUM, Linn.

Santalum Americanum, sp. nov.

Plate XXXII, Fig. 7.

Leaves thick, narrowly elliptical or oblong, very short-petioled, blunt at the apex; nervation obsolete.

The basilar border of the leaf is decurrent along the petiole, which is scarcely 2 millimeters long for a leaf 4 centimeters long, 1 centimeter broad in the middle. The affinity of this leaf is with the living *Santalum lanceolatum*, Brown. From the fossil species published, it differs in the very short petiole and the blunt apex of the leaves.

Hab.—Florissant. No. 638 of the collection of the Princeton Museum.

LAURINEÆ.

CINNAMOMUM, Burn.

Cinnamomum Scheuchzeri, Heer.

Plate XXXVIII, Fig. 6.

"U. S. Geol. Rep.," vii, p. 220, pl. xxxvii, fig. 8.

The leaf from Florissant more distinctly represents this species than that ("Rep." vii) from Montana. There is still a small difference from the European form in the position of the lateral nerves descending lower, nearly to the top of the petiole, and the basilar borders more distinctly decurrent. These deviations from the normal character are, however, somewhat indicated in a few of the numerous figures given by Heer of this species.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

PROTEACEÆ.

BANKSITES, Sap.

Banksites lineatus, sp. nov.

Plate XXXII, Fig. 21.

Seeds obliquely oval, winged; wings oblong, obtuse, larger on one side, distinctly striate lengthwise by 5 or 6 parallel black lines converging at the apex.

The seeds resemble those described as *Banksia Radobojensis*, Ung., "Syllog.," iii, p. 75, pl. xxiv, figs. 16, 17.

Hab.—Florissant; not rare, but as yet no leaves referable to this genus have been found there.

LOMATIA, R. Br.

Leaves coriaceous, pinnately laciniate or acutely lobed; divisions oblique, lanceolate, acute or acuminate, nerved in the middle, decurrent along the medial nerve or connected by a narrow wing at the basilar margin.

This definition merely relates to the peculiar leaves described below, whose relationship is marked only with leaves of some species of *Lomatia*. Their texture is thick. The surface is always covered by a coaly layer, obliterating the nervation.

Lomatia hakeæfolia, sp. nov.

Plate XXXII, Fig. 19.

Leaf obliquely truncate at base, lanceolate, acuminate, irregularly deeply dentate.

This form differs from the following by the segments, or lobes, being shorter and directed to the outside at right angles to the primary nerve; these acute short lobes or teeth, four on each side, are opposite and separated by broad shallow sinuses; no trace of secondary nerves is discernible.

Hab.—Florissant; rare. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Lomatia spinosa, sp. nov.

Plate XLIII, Fig. 1.

Leaves narrowly lanceolate, long-acuminate, broadly alternately acutely dentate-lobed; divisions gradually shorter upward, the terminal long-acuminate.

Related to the preceding species but differing by the laciniæ being longer, turned upward, decurrent. The primary nerve is scarcely visible.

Hab.—Florissant; rare. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Lomatia terminalis, sp. nov.

Plate XLIII, Figs. 2–7.

Leaves linear-lanceolate, acuminate, deeply lobate; lobes oblique, lanceolate, acute, decurrent along the primary thin nerve; lateral nerves generally distinct.

Hab.—With the preceding; not rare. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Lomatia tripartita, sp. nov.

Plate XLIII, Figs. 8–10.

Leaves palmately trilobate, narrowly cuneate to the base; lobes obliquely diverging, oblong, obtuse or obtusely pointed, entire or dentate-lobed on one side; primary nerves more or less distinct.

The three fragments representing this species may be mere forms of the preceding.

Hab.—Florissant; rare. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Lomatia acutiloba, sp. nov.

Plate XLIII, Figs. 11–16, 20.

Leaves long, linear-lanceolate, alternately pinnately lobed; lobes lanceolate or linear-lanceolate, acute, oblique, decurrent, gradually shorter upward, distinctly curved backward.

The divisions of the leaves, their shape and mode of decurring to a primary axis, are of the same type as in *Lomatia (Todea) Saportanea* of the "Cretaceous Flora" ("U. S. Geol. Rep."), vi, pl. xxix, figs. 1–4.

Hab.—Florissant. Common, and seen in all the collections.

Lomatia abbreviata, sp. nov.

Plate XLIII, Fig. 17.

Leaves linear or narrowly lanceolate; lobes oblique, short, oblong, not decurrent, cuneate at base, inclined upward, obtusely pointed; nerves obsolete.

This fragment appears related to fig. 10.

Hab.—Florissant; very rare. Collection of the Princeton Museum.

Lomatia interrupta, sp. nov.

Plate XLIII, Figs. 18, 19.

Leaves linear-oblong, larger in the middle, either lobes bi-form; larger, ovate, entire or obtusely dentate, or smaller intermediate to the larger ones, merely oval-obtuse, like short teeth.

This peculiar form has the lobes of the top and the base of the leaves simple, open, obtuse; in the middle the lobes become larger, obovate, obtusely irregularly dentate, opposite, and near their base the wing of the leaves is expanded into intermediate very small entire obtuse teeth. The large lobes, when entire, have only the medial nerve distinct; in the dentate ones the medial nerve is dichotomous, the branches passing up to the teeth, one or two on each side.

Hab.—Florissant; very rare. Princeton Collection, Nos. 842, 843.

Lomatia microphylla, Lesqx.

"U. S. Geol. Rep.," vii, p. 211, pl. lxv, figs. 14, 15.

PIMELEÆ.

PIMELEA, Banks.

Pimelea delicatula, sp. nov.

Plate XXXIII, Figs. 15, 16.

Leaves membranaceous, nearly sessile, spatulate, short-pointed or apiculate; secondary nerves emerging at an acute angle of divergence, branching on the lower part, variable in distance, separated by intermediate short veinlets; nervation camptodrome.

The leaves vary from 3 to 5½ centimeters long and from 8 to 13 millimeters broad in the upper part, near the apex, where they curve upward in narrowing to a short point, and from which part they are gradually narrowed downward to the very short petiole.

The species is closely allied to *P. Œningensis*, Heer, "Fl. Tert. Helv.," ii, p. 93, pl. xcvii, figs. 2–10, which has smaller leaves less gradually narrowed downward and no petiole.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

OLEACEÆ.

OLEA, Linn.

Of the numerous living species of this genus, one only, *Olea Americana*, inhabits the North American Continent; three species are European: the others are found in Tropical Asia and South Africa; Japan has one species.

The leaves of *Olea* are opposite, petioled, coriaceous, persisting, oblong-oval, obovate or lanceolate, very entire; the nervation pinnate, and the flowers fasciculate in the axils of the leaves.

Olea præmissa, sp. nov.

Plate XXXIII, Fig. 1.

Leaves coriaceous, lanceolate, larger below the middle, narrowed to a very short petiole; flowers in simple or rarely compound racemes.

The leaves average 5 centimeters in length and 1 centimeter in width below the middle, from which they are gradually tapering upward to a blunt point. The flowers are short-petioled, either single or in short slightly compound racemes. This character essentially separates this

species from *Olea Americana*, its nearest relative, from which it differs by smaller leaves and larger flowers. No trace of secondary veins is discernible on those leaves.

Nine fossil species of *Olea* are described by authors from the Miocene of Europe, none of which have a marked relation to this.

Hab.—Florissant. Princeton Collection, No. 641.

FRAXINUS, Tourn.

"U. S. Geol. Rep.," vii, p. 228.

Fraxinus prædicta, Heer.

Ibid., p. 229, pl. xl, fig. 3.

Fraxinus Heerii, sp. nov.

Plate XXXIII, Figs. 5, 6.

Leaflets more or less unequilateral, rounded or narrowed to the short petiole, and equally so from the middle to the acuminate blunt apex; borders undulate; lower secondary nerves at a more acute angle of divergence, all unequally distant, curving and reticulate at a distance from the borders; nervilles flexuous, at right angles to the medial nerve.

The leaflets, 5 to 7 centimeters long, 1½ to 2 centimeters broad, are, evidently, part of a compound leaf, as seen from the lower lateral leaflet, which is nearly sessile and very unequilateral, and the upper a terminal one, equilateral, larger and petioled. The lateral nerves are thin, arched toward the medial nerve at a distance from the borders, as in *Fraxinus prædicta*, Heer, "Fl. Tert. Helv.," pl. civ, figs. 12, 13, to which this species is closely related; indeed, it merely differs by the basilar nerves being at a more acute angle of divergence, and those above with curves more distant from the margins which are merely undulate. No fruiting part has been found.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Fraxinus mespilifolia, sp. nov.

Plate XXXIII, Figs. 7–12.

Leaflets more or less unequilateral, ovate-lanceolate, obtusely acuminate, rounded to a short petiole, obtusely serrate; secondary nerves parallel, subequidistant, 8 or 9 pairs, much curved in passing to the borders and following them, connected with the teeth by short anastomosing veinlets; nervilles oblique, very flexuous.

This species is as closely allied to *F. juglandina*, Sap., "Ét.," iii, p. 89, pl. ix, figs. 13–16, as is the preceding to *F. prædicta*, Heer. The leaflets

are broader, less unequal than in *F. Heerii*, rounded or narrowed on one side to a short petiole; the camptodrome veins follow close to the borders, not curving inside to the medial nerves, and the borders are always distinctly serrate. In *F. juglandina* the borders are sharply denticulate and the more open lateral veins do not ascend higher along the borders, as in the American species.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden*.

Fraxinus abbreviata, sp. nov.

Plate XXVIII, Figs. 5, 6.

Leaves short, ovate, acute, round or truncate at base, short-petioled, denticulate; secondary nerves close, parallel, open, curved in passing to the borders, much branching outside.

These leaflets, subequilateral, 3 to 5 centimeters long, 2 to 3 centimeters broad, with borders equally cut in acute small teeth slightly turned upward, have the lateral nerves close, 10 pairs, at an angle of divergence of 60°, somewhat curved in traversing the areas, much divided near the borders, the branches entering the teeth directly or by anastomosing veinlets. The nervation is like that of *Fraxinus ulmifolia*, Sap., "Ét.," iii, p. 91, pl. ix, figs. 17–19, differing essentially by shorter, comparatively broader, more equilateral leaflets, and less acute, more equal teeth. The relation of the species is very close.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden*. Seen also in Lacoe Cabinet, No. 26.

Fraxinus? myricæfolia, sp. nov.

Plate XXXIII, Figs. 13, 14.

Leaflets small, sessile, subcoriaceous, narrowly lanceolate, distantly dentate; secondary nerves very oblique, mostly obsolete.

The relationship of this fragment of leaf is obscure. The lateral nerves are obsolete and the leaflets sessile. Though the leaflet, fig. 14, has the same thick texture, the nerves scarcely distinct, it seems different on account of its short petiole and the direction of the secondary nerves, which is at an acute angle of divergence, apparently toward the teeth as craspedodrome. It may be a leaf of *Myrica*.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden*.

Fraxinus Ungeri, sp. nov.

Leaflet small, membranaceous, very entire, unequilateral, broadest below the middle, ovate-lanceolate, acuminate, narrowed to a short petiole.

There are three leaflets of the same kind remarkably similar in shape and size to *Fraxinus primigenia*, Ung., "Syllog.," i, p. 22, pl. viii, figs. 3–8. They are 4½ to 7 centimeters long, 1½ to 2½ centimeters broad below the middle, where they are much larger on one side than the other. The secondary nerves are parallel, open, curved in traversing the areas, branching near the borders, effaced in touching them. It may be the same species as that of Unger, but it is not possible to ascertain the degree of relationship, as in the leaflet representing the European species the secondary nerves are neither described nor distinctly figured.

Hab.—Florissant. Lacoe's Cabinet, No. 57.

Fraxinus Brownellii, Lesqx.

"U. S. Geol. Rep.," vii, p. 230.

Fraxinus Libbeyi, sp. nov.

Plate XXVII, Figs. 5–7, 9.

Leaves very variable in size, unequilateral, ovate-lanceolate, acuminate, rounded to a short petiole, irregularly serrate; secondary nerves parallel, close, 10 to 18 pairs according to size, branching near the borders, camptodrome, joined to the teeth by anastomosing veinlets.

The leaves vary from 3½ to 11 centimeters long, 1½ to 4 centimeters broad. They are very unequal at base, generally cut straight and obliquely on one side toward the petiole, enlarged and rounded on the other, deeply more or less irregularly serrate. Fig. 9 represents a long narrow leaf, broader in the middle, gradually narrowed upward and downward, rather oblong; the other leaves are broader toward the base and ovate; the secondary nerves are more or less divided near the borders, generally camptodrome, joined to the teeth by nervilles, a few of them entering the teeth; the nervilles are parallel, flexuous, simple or forking, or anastomosing at right angles in the middle; the areolation as seen in fig. 9 is formed of very small quadrate or round-quadrangular meshes.

Hab.—Florissant. Princeton Museum, Nos. 217, 245, 275, 281.

APOCYNEÆ.

APOCYNOPHYLLUM, Ung.

Leaves very entire, penninerve, coriaceous; medial nerves strong; secondary nerves very open or at right angles to the midrib, close together, camptodrome, sometimes separated by shorter intermediate thin veins.

Apocynophyllum Scudderi, sp. nov.

Plate XLV[a], Figs. 1–5.

Leaves oblong-lanceolate, gradually narrowed upward to an acumen and downward to a short petiole; secondary veins nearly at right angles, numerous, camptodrome, and curving quite near and along the borders as if joined to a continuous lateral nerve; intermediate tertiary nerves thinner, as long as the secondary ones; nervilles close, oblique.

The peculiar direction of the nerves, which in their curves follow the borders, appearing like a continuous marginal vein, is also a character of the leaves of some *Myrtaceæ*. The relationship of this species is, however, more marked, not only by the nervation but by size and form of the leaves with *Apocynophyllum Helveticum*, Heer, figured in "Bornst. Fl.," pl. iv, figs. 1–7. The curving of the veins close to the borders is distinctly seen (fig. 3) with the intermediate tertiary nerves, corresponding to fig. 4 of Heer. The form of the leaves and their size being also the same, possibly the American species is a mere variety.

Hab.—Alkali Station. Professor *Scudder*.

CONVOLVULACEÆ.

PORANA, Burm.

I have seen of this genus scariose calyxes, but, as yet, no leaves. These calyxes, 3- to 5-lobate, have the sepals generally of unequal length, free to the base, sometimes more or less connate. Two species only are described by authors with calyxes and leaves, six from scariose calyxes, all from the European Miocene.

Porana Speirii, sp. nov.

Plate XXVIII, Fig. 15.

Calyx scariose, somewhat thick, indistinctly five-lobate; lobes large, connate; nerves diverging from the central point to the borders, traversed at right angles by strong nervilles, forming equilateral meshes.

The lobes are marked only by their upper borders being connate to

near the rounded apex, where they are more than 1½ centimeters broad and of the same length. This form is related to *Getonia membranosa*, Goepp., "Schoss. Fl.," p. 38, pl. xxv, fig. 12, whose sepals are united to the middle and whose areolation is different. The size is the same.

Hab.—Florissant. Princeton Museum, No. 650.

Porana tenuis, sp. nov.

Calyx large, thin; sepals distinct to the base, oblong, obtuse; veins distinct, distantly obliquely branched.

Resembles *P. macrantha*, Ludw., "Palæontogr," viii, p. 116, pl. xli, fig. 18, but its sepals are still longer—more than 1½ centimeters long, and narrower, half a centimeter. The ramifications of the veins are much more distinct.

Hab.—Florissant. Lacoe's Cabinet, Nos. 65 and 71.

MYRSINEÆ.

MYRSINE, Linn.

Myrsine latifolia, sp. nov.

Plate XXXVIII, Fig. 16.

Leaf subcoriaceous, broadly oval or nearly round, truncate at base, very entire; nervation camptodrome.

The leaf, 2 centimeters long and as broad, is broken at the base and the top, and therefore the mode of attachment to the petiole is not seen. The nervation is, however, so much like that of species of this genus that its reference to it seems legitimate. The open, opposite, slightly curving, secondary nerves fork two or three times, and are divided toward the borders, where they abruptly curve and follow close to the margins in short anastomosing bows. The areas between the secondary nerves are obliquely crossed by branching nervilles constituting a loose polygonal areolation.

The affinity of this leaf as to its form and size is with *M. antiqua*, Ung., "Syllog.," p. 20, pl. vii, figs. 7, 7*b*. The European leaf is a little larger and the secondary nerves also a little more curved; the areolation is of the same type. The leaf appears to be unequilateral, and in this and size it is comparable to *M. Chamædrys*, Ung., "Fl. v. Sotzka," p. 42, pl. xxii, figs. 4, 5. The type of nervation of the American species is that of *M. bifaria*, Wall., of India.

The leaf described here is the only one seen as yet of this genus in the North American geological formations; thirty-four species have been described from the European Tertiary. The leaves are generally very small and have probably been unobserved until now.

Hab.—Florissant. Princeton Museum, No. 874.

SAPOTACEÆ.

BUMELIA, Swartz.

The plants of this genus have the leaves alternate, petiolate, coriaceous, and very entire. They inhabit at the present epoch tropical and boreal America. Ten fossil species are described from the European Continent.

Bumelia Florissanti, sp. nov.

Plate XXXIV, Figs. 4, 5.

Leaves thick, obovate, obtuse; lateral nerves thin, at an open angle of divergence, parallel, camptodrome.

The leaves, nearly 5 centimeters long and 3 broad in the upper part, are rounded at the apex, either slightly emarginate or apiculate, gradually narrowed to a very short petiole. Of the nervation nothing is distinct except the thin secondary nerves diverging at base at an angle of 60° to 70°, much curved in passing toward the borders, crossed at right angles by close nervilles, camptodrome. In size and shape these leaves are comparable to *Bumelia subspathulata*, Sap., "Ét.," iii, 3, p. 62, pl. 10, figs. 18–22, and in their different characters to the living *B. retusa* of Jamaica.

Hab.—Florissant; not rare. U. S. Geol. Expl. Dr. *F. V. Hayden.*

DIOSPYROS, Linn.

"U. S. Geol. Rep.," vii, p. 230.

Diospyros brachysepala, Al. Br.

Plate XXXIV, Figs. 1, 2.

Ibid., p. 232, pl. xl, figs. 7–10; lxiii, fig. 6.

The two leaves figured in this volume are more positively identified with the European species than the fragments of "Rep.," vii, pl. xl, whose affinity is still somewhat doubtful on account of the thickness of the secondary nerves.

Hab.—Florissant; not rare. Princeton Museum, Nos. 631, 657, &c.

Diospyros Copeana, Lesqx.

Plate XXXIV, Fig. 3.

"U. S. Geol. Rep.," vii, p. 232, pl. xl, fig. 11.

Though this leaf is shorter and its nervation more distinct, it has evidently the same characters as that described from Elko Station in vol. vii.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

MACREIGHTIA, A. D. C.

The fossil remains referable to this genus are represented by calyxes. These are merely tripartite; those of *Diospyros* are generally 4 to 6-lobed.

Macreightia crassa, sp. nov.

Plate XXXIV, Figs. 16, 17.

Calyx thick and coriaceous, trilobate; lobes cut to the middle, triangular.

Hab.—Florissant; not rare. Seen in all the collections.

ERICACEÆ.

ANDROMEDA, Linn.

"U. S. Geol. Rep.," vii, p. 234.

Andromeda delicatula, sp. nov.

Plate XXXIV, Figs. 10, 11.

Leaves submembranaceous, not thick, very entire, equally narrowed from the middle upward to a short blunt acumen, downward to a long slender petiole; nervation camptodrome.

These fine leaves average 5 centimeters long and 2 broad in the middle where they are widest. The lateral nerves at an angle of divergence of 40° curve in passing to the borders and follow them in anastomosing bows. They are parallel, unequal in distance; the basilar ones follow close to the borders at a more acute angle of divergence. This and the smaller size of the leaves, more enlarged in the middle, separate this species from *A. protogœa*, Ung., in Heer, "Fl. Tert. Helv.," p. 8, pl. ci, fig. 26.

There is in Lacoe's Cabinet a number of oblong or linear-lanceolate leaves narrowed to a long petiole, exactly similar to those of *A. protogœa* as figured by Heer, *loc. cit.*, but without trace of nervation. They seem indeed referable to the European species.

Hab.—Randolph Co., Wyoming. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Andromeda rhomboidalis, sp. nov.

Leaves rhomboidal in outline, enlarged in the middle, narrowed downward to a long slender petiole and equally so upward to an obtuse apex; nervation obsolete.

The leaves without the petiole are 3 centimeters long, 18 millimeters broad in the middle; the very slender flexuous petiole is broken 1½ centimeters from the base of the leaf.

Species comparable to *A. tremula*, Heer, "Fl. Tert. Helv.," p. 9, pl. ci, fig. 25. The leaves are, however, more enlarged in the middle.

Hab.—Florissant. Lacoe's Cabinet, No. 70.

VACCINIUM, Linn.

Vaccinium reticulatum?, Al. Br.

"U. S. Geol. Rep.," vii, p. 235, pl. lix, fig. 6.

ARALIACEÆ.

ARALIA, Tourn.

"U. S. Geol. Rep.," vii, p. 235.

Aralia dissecta, sp. nov.

Plate XXXV.

Leaves palmately seven-lobed; primary segments cut to three-fourths of the lamina, oblong-lanceolate, deeply lobate, dentate above; secondary divisions lanceolate, obtusely dentate-lobed; sinuses obtuse; secondary nerves subopposite, thick, pinnately branching; nervation craspedodrome.

Of the seven lobes of this fine leaf three are preserved nearly entire and sufficiently represent its character. The leaf, nearly round or fan-shaped in outline, 19 centimeters long from the top of a very thick petiole to the apex of the medial lobe, is cut into seven primary divisions, all pinnately or bipinnately lobate-dentate; the lobes and teeth oblique, slightly turned up, each entered by one of the secondary or of the tertiary nerves, all the nerves therefore corresponding to one division of the leaves and united by nervilles at right angles. There are no intermediate veins passing up to the base of the lobes as in the large fragments which I have referred to *Myrica* as *M. insignis* and *M. Lessigii* of vol. vii, which have apparently a kind of primary division like this leaf.

This fine species is closely related to *Aralia multifida*, Sap., "Ét.," i, 1, p. 115, pl. xii, fig. 1, from which it differs merely by the primary divisions being regularly pinnately lobed, the lobes also pinnately lobed or deeply

dentate, the teeth shorter and more obtuse. Saporta compares his species to *Aralia elegans* of New Grenada, a plant cultivated in gardens, which from the figure given by the author seems like a counterpart of the fossil leaf.

Hab.—Florissant. This splendid specimen is in the Princeton Museum, No. 659.

HEDERA, Linn.

Hedera marginata, sp. nov.

Plate XL, Fig. 8.

Leaf small, coriaceous, nearly round in outline, truncate at base, deeply sharply lobate all around; nervation five-palmate from the base, the nerves directed toward the points of the lobes, united by nervilles at right angles.

I know nothing to which this leaf may be related. In shape and nervation it seems a species of *Hedera* comparable by these characters to *H. prisca*, Sap., "Séz. Fl.," p. 380, pl. x, fig. 1, which, however, is a large leaf with short obtuse teeth.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

AMPELIDEÆ.

CISSUS, Linn.

Cissus parrotiæfolia, Lesqx.

"U. S. Geol. Rep.," vii, p. 239, pl. xl, figs. 15–17.

AMPELOPSIS, Mich.

Ibid., p. 242.

Ampelopsis tertiaria, Lesqx.

Ibid., p. 242, pl. xliii, fig. 1.

SAXIFRAGEÆ.

WEINMANNIA, Linn.

Leaves simple, ternate, quinate or odd-pinnate; petiole articulate; rachis often alate, rarely entire; secondary nerves thin, camptodrome or craspedodrome.

The leaves which I refer to this genus have been referred by authors either to *Zanthoxylum* or *Celastrus*, or especially to *Rhus*, as I have done in vol. vii. Fine figures of species of *Weinmannia* from specimens obtained by Rev. *Probst* from the Tertiary of Biberack, and communicated to me by Heer, show such a close relation to the leaves described from Florissant that their reference to the same genus cannot be doubted.

Weinmannia Haydenii, Lesqx.

Plate XLII, Figs. 1–7.

Rhus Haydenii, Lesqx., "U. S. Geol. Rep.," vii, p. 294, pl. lviii, fig. 12.

Leaves imparipinnate; rachis winged; leaflets opposite or alternate, sessile, membranaceous, narrowly lanceolate, obtusely serrate; nervation pinnate, craspedodrome; nervilles at right angles to the secondary veins, anastomosing in the middle of the areas and forming a small polygonal areolation.

The rachis is winged and nerved; the leaflets are joined to the midrib by their primary nerves, and their borders are continued at base by a narrow margin along the rachis.

Hab.—Florissant. Very abundant; seen in all the collections. The figures are from specimens obtained by the U. S. Geol. Expl. Dr. *F. V. Hayden*.

Weinmannia integrifolia, sp. nov.

Plate XLII, Figs. 8–13.

Leaves narrower than in the preceding species; leaflets narrow, entire, oblong or sublinear, blunt at the apex, more distinctly turned upward; nervation camptodrome.

Except that the leaflets are narrower and entire and the nervation consequently camptodrome, the characters are the same and this form may represent only a distinct variety. The leaves of these two species are polyphyllous, the number of their leaflets being much greater than in any other species living at this epoch. This difference and the nearly linear wing of the petiole relate them to *Rhus*.

Hab.—With the preceding and quite as common.

Weinmannia obtusifolia, sp. nov.

Plate XLI, Figs. 4–10.

Leaflets close, the upper pairs decurrent and connate at base, the lower more distant, bordering the rachis by their decurrent base; wing obtusely dentate or convex in the middle; leaflets oblong-obtuse or subspatulate, very entire, more rigid than in the two preceding species, membranaceous; nervation camptodrome.

As in the other species, the leaflets are alternate or opposite, narrowed toward the base or larger toward the obtuse or rounded apex; the leaves are generally smaller, shorter, with fewer leaflets.

Hab.—Florissant; not as frequent as the two preceding ones.

MALVACEÆ.

STERCULIA, Linn.

Schimper remarks, on the present distribution of this genus, that it has made its appearance in Europe at the first stage of the Tertiary, as it is already reported in the "Flora of Sézanne;" that it has had its largest representation in the Miocene, and has since totally disappeared from the continent. The numerous forms of leaves of this genus described in this volume from the Dakota Group prove that the origin of these plants should be removed to the Cretaceous for the American continent at least. The genus is thence found in the divers stages of the Tertiary, but far less frequently here than in Europe.

Sterculia rigida, sp. nov.

Plate XXXIV, Fig. 12.

Leaf subcoriaceous, rigid, cuneate at base, tripalmately lobed; lobes cut to near the base, narrowly lanceolate, sharply acuminate, very entire, the lateral shorter and narrower; nervation obsolete.

I have seen another leaf of the same character since the first was figured, but it does not show anything more except the base, which is cuneate, or like a continuation of fig. 12, to the top of the petiole. The leaves are small, 5½ centimeters between the points of the lateral lobes, 7 centimeters long from the base to the apex of the medial lobe which is 6 centimeters long, the lateral only four. The only species related to this is *S. Labrusca*, common in the Miocene, but the relation is distant.

Hab.—Florissant; very rare. Princeton Museum, No. 667. Lacoe's Collection, No. 44.

TILIACEÆ.

TILIA, Linn.

Tilia populifolia, sp. nov.

Plate XXXIV, Figs. 8, 9.

Leaves large, round or subcordate at base, deltoid-acuminate to the apex, deeply regularly serrate, palmately five-nerved; upper lateral nerves somewhat thicker and more distant, the secondary parallel, slightly curving, branching near the borders. Leaves large, variable in size.

At first the leaf, fig. 8, seems to represent a *Populus* on account of the

lateral primary nerves being much stronger than the secondary; but all the nerves and their divisions are craspedodrome; the nervation is positively that of a *Tilia*. In fig. 9 the primary nerves, though more distant, are not stronger, and the teeth of the borders are triangular, somewhat unequal, not turned up as in fig. 8, except toward the base, where they have evidently the same character in both leaves. The teeth are very variable on the borders of the leaves of *Tilia*, even on those of the same tree, and the habitat being the same I refer these to the same species.

Hab.—Florissant. Princeton Museum, Nos. 886 and 887.

ACERACEÆ.

ACER, Linn.

"U. S. Geol. Rep.," vii, p. 260.

Acer æquidentatum, Lesqx.

Ibid., p. 262, pl. xlviii, figs. 1-3.

Acer indivisum, sp. nov.

Plate XXXVI, Figs. 6, 9.

Leaves small, of thin texture, round-truncate in outline, five-nerved and five-lobed; lobes entire, sharply acuminate; sinuses broad, entire or dentate in the middle; petiole comparatively long, inflated under the point of attachment.

The leaves are 5½ centimeters broad between the points of the upper lobes and only 4 centimeters long from the top of the petiole, which is 5½ centimeters long. They are truncate at base, the lower lobes shorter, turned outside at right angles to the medial nerve; the upper lateral ones a little longer, also turned outside. The primary nerves are thin; no trace of secondary nervation is seen.

This species is comparable to *Acer Sibiricum*, Heer, "Fl. Foss. Arct.," v, p. 46, pl. x, figs. 4*b*, 5*a*, 5*b*; xi, fig. 2, differing by the base of the leaves being truncate and entire, not dentate, the sharply acuminate longer lobes, the terminal also entire, the medial nerve being simple like the lateral ones, without branches going to the borders. The affinity of this leaf is more evidently marked with *Acer rubrum*, to which the fruit, fig. 9, is still more intimately related.

Hab.—Randolph Co., Wyoming. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Acer, species.

Plate XXXVI, Figs. 7, 8.

Leaves rounded to the petiole, palmately three-nerved and three-lobate; borders dentate.

The leaves are too much broken for determination and definitive description; they appear related to some of the varieties of *Acer trilobatum*, Al. Br.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

SAPINDACEÆ.

SAPINDUS, Linn.

"U. S. Geol. Rep.," vii, p. 263.

Sapindus stellariæfolius, Lesqx.

Ibid, p. 264, pl. xlix, fig. 1.

Sapindus angustifolius, Lesqx.

Plate XXXVII, Figs. 1-8; XXXIX, Fig. 12.

Ibid., p. 265, pl. xlix, figs. 2-7.

The numerous forms figured of this species, common at Florissant, shows the great variety of its leaflets. Though comparatively large, the leaves of pl. xxxix, fig. 12, appear referable to it. The specimens, however, may represent two specific forms, which can be separated only when the nervation is known.

Sapindus coriaceus, Lesqx.

"U. S. Geol. Rep.," vii, p. 265, pl. xlix, figs. 12-14.

Sapindus Dentoni, Lesqx.

Ibid., p. 265, pl. lxiv, figs. 2-4.

Sapindus obtusifolius, Lesqx.

Ibid., p. 266, pl. xlix, figs. 8-11.

There is a fine specimen of this species from Florissant in M. Lacoe's cabinet, No. 48. The leaflets are disposed as in fig. 8, *l. c.*, but they are still smaller, the lower 1½ centimeters, the upper 1 centimeter, all more distinctly obtuse.

Sapindus inflexus, sp. nov.

Plate XXXII, Fig. 2.

Leaves subcoriaceous, unequilateral at the narrowed base, lanceolate-acuminate; lateral nerves much curved and following the borders in anastomosing with the upper ones.

The form of the leaflet and its nervation indicate its reference to this genus. It is distantly related to *S. undulatus*, Heer, "Fl. Tert. Helv.," iii, p. 62, pl. cxxi, figs. 3–7.

Hab.—Florissant. Princeton Museum, No. 763.

Sapindus lancifolius, sp. nov.

Plate XXXII, Figs. 3–6; XXXVII, Fig. 9.

Leaves subcoriaceous or membranaceous, petioled and more or less unequilateral at the rounded base, lanceolate, long-acuminate, very entire; secondary nerves close, parallel, nearly at right angles to the narrow midrib, straight or slightly curved in traversing the lamina, abruptly curving near the borders and anastomosing in simple bows.

These leaflets, 6½ to 7 centimeters long and more or less than 2 centimeters broad, have the lateral veins close, parallel, united by oblique simple nervilles and nearly without branches. They are distinctly related to *S. Græcus*, Ung., "Fl. v. Kumi," p. 49, pl. xii, figs. 1–23. In this species the veins are equally close and numerous at right angles to the midrib and the leaves have the same form; they are, however, generally smaller. As in those of Florissant, the petiole is 1 centimeter long. In fig. 9 of pl. xxxvii the leaf is narrowed to the petiole, which appears longer; the veins are not as open nor as numerous; its reference to this species is not certain.

Hab.—Florissant. Princeton Museum, Nos. 644 and 645.

DODONÆA, Linn.

I have referred to this genus the seed, pl. xxxvi, fig. 5, on account of its great likeness to that of *D. canescens*, D. C., figured by Ettinghausen in "Fl. v. Här.," pl. xxiii, o. The nucleus is, however, harder, more distinct, and the wings also more distantly veined. It is, perhaps, a seed of *Ulmus*, like those figured, pl. xxvii, fig. 8, from which it differs merely by its slender pedicel. No leaves of *Dodonæa* have been observed in the Green

River Group. The leaves of *Ulmus* are on the contrary very abundant at Florissant and other localities of the North American Tertiary where fossil plants have been obtained.

STAPHYLEACEÆ.

STAPHYLEA, Linn.

"U. S. Geol. Rep.," vii, p. 267.

Staphylea acuminata, Lesqx.

Plate XXXVI, Figs. 1-4.

Ibid., p. 267, pl. xlviii, figs. 4, 5.

The species is not rare at Florissant, but generally the leaves are defaced by maceration and their characters obscurely defined.

FRANGULACEÆ.

EVONYMUS, Tourn.

Leaves opposite, petiolate, ovate, serrate or dentate, pinnately nerved; secondary nerves camptodrome or effaced in the reticulation toward the borders.

Ten fossil species of this genus are described from the European Tertiary, mostly from the Miocene.

Evonymus flexifolius, sp. nov.

Plate XXXVIII, Fig. 13.

Leaves large, ovate-acuminate from an oval base, flexuous at the apex, narrowed from the middle to the petiole, sharply deeply serrate; secondary nerves alternate, equidistant and parallel, camptodrome.

The leaf without the petiole is 16½ centimeters long, 5 centimeters broad in the middle, where it is oval-oblong, narrowed upward to a long flexuous acumen and more rapidly to the petiole, which is 3 centimeters long. The teeth of the borders are turned upward, equal, becoming short toward the acumen, deeply cut; the nervation is truly camptodrome, the veins being effaced near the borders and not entering the teeth directly as it is incorrectly figured.

This leaf has the characters of *Evonymus Proserpinæ*, Ett., "Bil. Fl.," iii, p. 30, pl. xlviii, figs. 6, 7. It is of the same size and shape, more grad-

ually and longer acuminate; the border teeth are larger and more acute. The details of nervation are obsolete.

Hab.—Randolph Co., Wyoming. U. S. Geol. Expl. Dr. *F. V. Hayden.*

CELASTRUS, Linn.

"U. S. Geol. Rep.," vii, p. 268.

Celastrus Lacoei, sp. nov.

Leaves subcoriaceous, obovate or spatulate, rounded and dentate at the apex.

The leaf is remarkably similar in character to those described by Heer as *C. cassinefolius*, Ung., in "Fl. Tert. Helv.," iii, p. 67, pl. cxxi, figs. 24–26, whose leaves are longer and narrower, obtusely dentate or rather crenulate from the middle upward.

Hab.—Florissant. Lacoe Collection, No. 49.

Calastrus Greithianus, Heer.

"Fl. Tert. Helv.," iii, p. 70, pl. cxxi, fig. 63.

Leaves small, broadly oval, obtuse, very entire, abruptly narrowed to the petiole; lateral nerves nearly at right angles to the midrib, camptodrome.

Two leaves from Florissant are referred to this species. One is of the same size, form, and nervation as that figured by Heer, the other is more gradually narrowed to the base, lacerated at the rounded apex. This last leaf is more like *C. Bruckmanni*, Heer, *l. c.*, fig. 32.

Hab.—Florissant. Lacoe Collection, No. 74.

Celastrus fraxinifolius, sp. nov.

Plate XXXIII, Figs. 2–4; Plate XL, Fig. 10.

Leaves membranaceous, narrowly elliptical in the middle, lanceolate, acuminate, blunt at the apex, narrowed and decurrent to the petiole, crenulate-dentate; secondary nerves at an acute angle of divergence, curving to the borders and reticulate along them.

The leaves, 5 to 7 centimeters long, averaging 2 centimeters in width in the middle, are mostly equilateral at the narrowly cuneate base, short-petioled, the petiole ½ centimeter long, being bordered by the decurrent base of the leaves; the lateral nerves unequally distant, much and unequally curved in traversing the lamina, follow the borders in multiple reticulations without entering the teeth, which are distant, obtuse, sometimes obsolete.

The leaves have a great affinity in their characters to those of species of *Fraxinus.* They are, however, equilateral on the borders and the nervation is different. Figure 3 of pl. xl may represent another species; the leaf is broader and slightly unequilateral. The decurrent base of the leaf and the type of nervation are the same.

Hab.—Florissant; not rare. U. S. Geol. Expl. Dr. *F. V. Hayden.* Fig. 10 represents two leaves, Nos. 648 and 870 of the Princeton Museum.

Celastrinites elegans, sp. nov.

Plate XXXI, Figs. 9, 10.

Leaves nearly round, membranaceous, somewhat long-petioled, crenate on the borders; nervation pinnate; secondary veins oblique, parallel, reticulate and effaced along the borders.

The leaves are very small, 1½ to 2½ centimeters long and about the same width, rounded or broadly cuneate to the petiole.

Figure 10 is truncate at base and its nervation appears triple-nerved, as in *Populus;* but the surface is somewhat erased and the upper secondary nerve obsolete, and as all the other characters are alike the difference is not considered.

Hab.—Florissant. Princeton Museum, Nos. 799 and 868.

ILICEÆ.

ILEX, Linn.

"U. S. Geol. Rep.," vii, p. 269.

Ilex pseudo-stenophylla, sp. nov.

I. stenophylla, Lesqx.; Hayden's "Ann. Rep.," 1871, Supp't, p. 8.

Leaves small, coriaceous, very entire, obovate or oblanceolate, obtuse, short-pedicellate; medial nerve thin; lateral nerves very oblique, much curved near the borders, anastomosing.

The leaf is much like those of *I. stenophylla,* Ung., "Syllog.," ii, p. 14, pl. iii, figs. 15, 27, being, however, smaller with a shorter broad pedicel. The nervation is like that of figs. 24 and 25 of Unger. The leaves described in Hayden's "Ann. Rep.," *loc. cit.,* have the same degree of affinity to Unger's species and are all larger. They apparently represent an American variety of the species.

Hab.—Florissant. No. 59 of Lacoe's Collection.

Ilex microphylla, sp. nov.

Leaves small, coriaceous, obovate or spatulate, rounded and denticulate at the apex, narrowed to a short broad petiole; secondary nervation obsolete.

The leaf, 2½ centimeters long, 7 millimeters broad in the upper part, is gradually narrowed to a petiole 7 millimeters long. Its affinity, which is close indeed, is with *Ilex ambigua*, Ung., "Syllog.," ii, p. 14, pl. iii, fig. 29, from which it differs merely by the gradually narrowed base of the leaf and the longer petiole.

Hab.—Florissant. No. 60 of Lacoe's Collection.

Ilex maculata, sp. nov.

Plate XLIV, Fig. 5.

Leaves coriaceous, obovate, obscurely and irregularly crenulate, narrowed to the petiole; medial nerve narrow, the lateral at a broad angle of divergence, a little curved in traversing the blade, effaced toward the borders.

The leaf is badly preserved; its surface is maculated or gnawed by parasite hypophylles or insects. Its shape and thick consistence appear to refer it to this genus.

Hab.—Alkali Station. Professor *Scudder*.

Ilex Wyomingiana, Lesqx.

"U. S. Geol. Rep.," vii, p. 270, pl. l, fig. 1.

Ilex? affinis, Lesqx.

Ibid., p. 270, pl. l, figs. 2, 3.

Ilex subdenticulata, Lesqx.

Ibid., p. 271, pl. l, figs. 5, 6–6*b*.

Ilex dissimilis, Lesqx.

Ibid., p. 271, pl. l, figs. 7–9.

Ilex quercifolia, sp. nov.

Plate XXXVIII, Figs. 2–5.

Leaves coriaceous, short-petioled, obovate, abruptly acuminate, irregularly acutely dentate from near the base; secondary nerves at a broad angle of divergence, slightly curved in passing to the borders, entering the teeth directly or by branchlets; intermediate tertiary veins short, anastomosing with nervilles in the middle of the areas.

The leaves are very variable in size (from 12 millimeters long to nearly 6 centimeters, and 5 millimeters to 2 centimeters broad); the petiole is thick and short (6 millimeters long); the teeth turned outside, sharply

pointed, are distant and variable in length, separated by obtuse sinuses; the acumen is sharply pointed.

The relation of this species is distinctly indicated to *Ilex dryandræfolia*, Sap., "Ét.," i, 2, p. 89, pl. x, fig. 8, a leaf which is much like fig. 2 of our plate, and which merely differs by the secondary nerves being at right angles to the midrib, rather curved backward than upward, a difference scarcely noticeable enough to authorize specific distinction. The *Ilex odora*, Sieb. and Zucch., of Japan, has the leaves remarkably similar to both these fossil species.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Ilex grandifolia, sp. nov.

Plate XXXVIII, Fig. 1.

Leaves large, membranaceous, oblanceolate or obovate, irregularly dentate; lateral nerves very oblique, more or less curved in traversing the blade, camptodrome, joined to the borders and the teeth by anastomosing nervilles.

The leaf seems to have been very large, the fragment preserved (the upper half) being 8 centimeters long and 5 centimeters broad. It appears to have been rounded at the apex and gradually narrowed to the base, the lower lateral nerves being very oblique and following the borders in curves. The nervation is irregular. The lateral nerves, diverging about 30°, are distant, parallel, with few intermediate tertiary shorter thin veins, and in their curves they generally ascend to near the borders, but also sometimes curve in the middle of the areas, anastomosing with the divisions of the first nerves above and sending strong outside branches toward the borders. The teeth are somewhat unequal but not as large as in the preceding species, more or less inclined upward, acute. The subdivision of the primary areas is by nervilles at right angles to the nerves, anastomosing generally at right angles with the thinner tertiary veins, producing a large irregularly quadrate areolation.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Ilex knightiæfolia, sp. nov.

Plate XL, Figs. 4, 5.

Leaves membranaceous, linear in outline, decurrent to the petiole, rounded and acuminate at the apex, deeply dentate; secondary nerves at right angles, curving abruptly and anastomosing at right angles at a distance from the borders, joined to the teeth by nervilles; teeth large, irregular in distance, turned outside and sharply pointed.

These leaves have peculiar characters which seem to refer them to some types of the *Proteaceæ* of New Holland, *Banksia Hugelii*, R. Br., and species of *Knightia*. The small leaf, fig. 5, is better preserved but not sufficiently so to show the base of the leaf which, being lacerated, appears to follow and border the thick petiole to its point of attachment. The teeth, like the secondary nerves, are at right angles to the midrib except near the apex, which is formed of a sharply angular point; the secondary nerves are separated by slightly thinner and shorter tertiary ones, anastomosing with nervilles at right angles in traversing the areas and united to the upper part by curves or strong nervilles also at right angles.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

RHAMNEÆ.

"U. S. Geol. Rep.," vii, p. 272.

PALIURUS, Tourn.

Paliurus Florissanti, Lesqx.

Ibid., p. 274, pl. l, fig. 18.

Paliurus orbiculatus, Sap.

Plate XXXVIII, Fig. 12.

Saporta, "Ét.," iii, 2, p. 182, pl. vii, fig. 6.

Leaves small, membranaceous, orbicular, very entire, triple-nerved from the base; lateral nerves curved upward in ascending to near the apex, where they unite to the secondary nerves which are distant and few.

Though the nervation is not as distinct as in the leaf published by Saporta, the affinity is so clear that it is not possible to doubt specific identity; the basilar nerves, equally branching, ascend high, joining the few secondary nerves, one of which only is distinct in the specimen of Florissant and two only on that figured by Saporta, who described the

tertiary veinlets as flexuous and reticulate. The leaf is nearly of the same size, 2 centimeters in diameter both ways.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

ZIZYPHUS, Mill.

"U. S. Geol. Rep.," vii, p. 275.

Zizyphus cinnamomoides, Lesqx.

Ibid., p. 277, pl. lii, figs. 7, 8.

RHAMNUS, Linn.

Ibid., p. 278.

Rhamnus oleæfolius, sp. nov.

Plate XXXVIII, Fig. 14.

Leaves thick, oblong-lanceolate, narrowed at base, blunt at the apex; secondary veins thick, at an acute angle of divergence, curving close to the borders.

The leaf, 6½ centimeters long, 18 millimeters broad, has the primary and secondary nerves thick, but no trace of nervilles; the lateral veins are nearly straight to near the borders and abruptly curve in reaching them, appearing to join the margin by their ends. The same character of nervation is remarked in *R. marginatus,* Lesqx., "Trans. Phil. Soc.," vol. xiii, p. 420, pl. xxii, figs. 3–5, which, however, differs much in the form and size of the leaves.

Hab.—Florissant. Princeton Museum, No. 687.

Rhamnus notatus?, Sap.

Plate XXXVIII, Fig. 15.

Sap., "Ét.," iii, 1, p. 103, pl. xi, fig. 5.

Leaves subcoriaceous, very short-petioled, entire or slightly undulate in the upper part, round ovate, obtusely pointed; lateral nerves 6 to 7 pairs, parallel, curved; nervilles oblique, transversely reticulate.

This leaf is, in its form and size, like a counterpart of that of Saporta, *l. c.* It is also rounded at base to a very short petiole, curved toward the apex and there obscurely undulate or crenulate. The lower secondary veins are opposite, three pairs. In the figure of the French author all the veins are alternate except the basilar ones; but there is also no trace of nervilles visible as upon the specimens of Florissant.

Hab.—Florissant. Princeton Museum, No. 643.

TEREBINTHINEÆ.

JUGLANDEÆ.

"U. S. Geol. Rep.," vii, p. 283.

JUGLANS, Linn.

Juglans Schimperi, Lesqx.

Ibid., p. 287, pl. lvi, figs. 5–10.

Juglans denticulata, Heer.

Ibid., p. 289, pl. lviii, fig. 1.

Juglans Florissanti, sp. nov.

Leaf large, lanceolate-acuminate from a rounded unequilateral base; lateral veins thick, much curved in traversing the blade, camptodrome; borders dentate.

The leaf is 11 centimeters long, 4½ centimeters broad in the middle; its surface is rough and altogether of coarse aspect—the primary and secondary nerves being thick. The details of areolation and subdivisions of the nerves are obsolete. It is comparable to a leaf of *J. bilinica*, figured in Heer, "Fl. Tert. Helv.," p. 90, pl. cxxx, fig. 7, but it is thicker, coarser, with more prominent nerves.

Hab.—Florissant. Lacoe's Collection, No. 80.

Juglans alkalina, Lesqx.

"U. S. Geol. Rep.," vii, p. 288, pl. lxii, figs. 6–9.

Juglans costata, Ung.

Plate XXXIX, Fig. 5.

Carya costata, Ung., "Syllog.," p. 41, pl. xxxix, fig. 16.
Juglans costata, Ludw., "Palæontogr.," viii, p. 138, pl. lvii, fig. 7 (leaf); liv, fig. 15 (nut).
Juglans acuminata?, Heer, Lesqx., Suppl. to Hayden's "Ann. Rep.," 1871, p. 8.

Leaflets broadly oval, obtuse, slightly mucronate, somewhat unequilateral or turned to one side, rounded at base to a short petiole; nervation camptodrome. Nut round-ovate, short-pointed; lobes of the seed simple, oblong.

In the short description of the leaflet as *J. acuminata?*, *loc. cit.*, I remarked that it has exactly the same characters as the one figured by Heer, "Fl. Tert. Helv.," pl. cxxix, fig. 6, which appears far different from any other forms of this species, and that it is comparable to *J. costata*, Ung., as figured by Ludwig, *l. c.* As one of the specimens of Florissant has a nut very much like that published by the same author, *l. c.*, the

identification of the American specimens with Ludwig's species is legitimate.

Hab.—Florissant. Princeton Museum, No. 712 (nut).

CARYA, Nutt.

Carya bilinica, Ung.

Plate XXXIX, Figs. 1, 2, 13.

Ung., "Syllog.," p. 39, pl. xvii, figs. 1–10; "Fl. v. Kumi.," p. 54, pl. xiv, fig. 13; Ét., "Bil. Fl.," iii, p. 46, pl. li, figs. 4–6, 13, 15; lii, figs. 3, 4, 7–11.

Leaves odd-pinnate; leaflets short-petioled, oblong or narrowly ovate, lanceolate, acuminate, serrate; lateral nerves camptodrome, parallel.

These fine leaves correspond to the description and figures given of the species by European authors; the borders of the leaves are more or less distinctly serrulate, as shown in fig. 2; fig. 13 shows a variety represented also by the specimens of Mr. Lacoe, which might, perhaps, be separated into a different species, but except the smaller size of the long-acuminate leaflets, the characters are the same.

Hab.—Florissant; not rare. U. S. Geol. Expl. Dr. *F. V. Hayden.* Lacoe's Collection, No. 40, in leaves still smaller than fig. 1.

Carya rostrata, (Goepp.), Schp.

Plate XXXIX, Fig. 4.

Ludw., "Palæontogr.," viii, p. 136, pl. lv, figs. 5–7.

I refer this nut to the species of Ludwig described as quoted above. As we have only on the Florissant shale the representative of a drupe or of the husk, its reference to the European species known by fruits and leaves is not more ascertainable than that of the preceding.

Hab.—Florissant. Princeton Museum, No. 711.

Carya Bruckmanni?, Heer.

Plate XXXIX, Fig. 6.

Heer, "Fl. Ter. Helv.," iii, p. 93, pl. cxxvii, fig. 52.

Fruits small, oval, constricted into an obtuse apex, costate.

The fruit is still smaller than that in Heer, *loc. cit.*, and as the inside of the nut only is shown upon the face of the specimen it is not possible

to see whether this small nut is costate. Therefore, as in the two preceding species, the reference is uncertain.

Hab.—Florissant. Princeton Museum, No. 709.

PTEROCARYA, Kunth.

Pterocarya Americana, Lesqx

"U. S. Geol. Rep.," vii, p. 290, pl. lviii, fig. 3.

ENGELHARDTIA, Leschen.

Leaves abruptly pinnate; leaflets unequilateral, generally resinose, punctate on the lower surface; primary nerves strong, secondary thin, camptodrome, anastomosing. Flowers agglomerated in paniculate ears; drupe small, connate at base to a tri-alate involucre; dorsal lobe generally absent (in fossil specimens), epicarp coriaceous, putamen bicostate.

Engelhardtia oxyptera, Sap.

"Ét.," ii, p. 344, pl. xii, fig. 2.

Lobes of the involucre linear-oblong, obtusely pointed, the lateral half as long as the middle; medial nerve distinct to the point, the lateral open-oblique, camptodrome.

The involucre from the base of the nucleus to the top of the medial lobe is 3 centimeters long, a little more than 2 to the top of the lateral ones. The basilar nervation of the middle lobe is in two short basilar parallel nerves and above in curved secondary nerves, as in the lateral lobes; all the nerves are camptodrome and anastomosing. The involucre is only slightly larger than in Saporta's figure; the nervation is the same.

Hab.—Florissant. *Wm. Cleburne.*

ANACARDIACEÆ.

RHUS, Linn.

"U. S. Geol. Rep.," vii, p. 291.

Rhus fraterna, sp. nov.

Plate XLI, Figs. 1, 2.

Leaves simple, submembranaceous, long-petioled, rhomboidal-oval, equally narrowed to the acute apex and to the petiole, very entire; medial nerves narrow, the lateral thin, nearly parallel, oblique, much branching, and obliquely reticulate toward the borders.

The leaves average 4 centimeters long and 2 broad in the middle, the widest part. The nervation is delicate but very distinct; the secondary

nerves, at an angle of divergence of about 40°, pass toward the borders, slightly curved and obliquely branching, especially near the borders; the nervilles are mostly at right angles to the midrib. Except that the petiole of the leaves is longer, nearly 2 centimeters, and the leaves slightly more enlarged in the middle, the species is, in all its characters, identical with *Rhus palæocotinus*, Sap., "Ét.," ii, p. 352, pl. xii, fig. 6, closely allied to the well-known *R. Cotinus*, Linn.

Hab.—Florissant. Princeton Museum, Nos. 783 and 875.

Rhus coriarioides, sp. nov.

Plate XLI, Fig. 3.

Leaves odd-pinnate; leaflets narrowly lanceolate, gradually acuminate, narrowed in rounding to the base, sessile; borders distantly serrate; lateral nerves curved, craspedodrome.

The leaflets are opposite, at least in the upper part of the leaves, 6½ centimeters long, 10 to 12 millimeters broad toward the base; the teeth are short, turned upward, gradually smaller toward the apex, where the borders are entire as near the base. The affinity of this species is with *Rhus glabra*, Linn., of the present North American Flora, and especially with the European *R. coriaria*, Linn., which merely differs by the larger teeth of the borders.

Hab.—Florissant. Princeton Museum, No. 858.

Rhus cassioides, sp. nov.

Plate XLI, Fig. 11.

Leaves trifoliate or odd-pinnate; leaflets obovate, the terminal twice as large as the lateral ones, entire; lateral veins close, 8 to 10 pairs, parallel, curved in passing to the borders, craspedodrome.

The specimen does not indicate whether the three leaflets figured pertain to an odd-pinnate leaf or to a trifoliate one, the axis or pedicel being broken under the point of attachment of the leaflets. The terminal one is 2½ centimeters long, 12 millimeters broad above the middle; the lateral 14 to 15 millimeters long and 6 millimeters broad; the lateral veins, quite distinct, follow close to the borders in their curves and are united by close nervilles at right angles, simple or anastomosing in the middle.

The nervation is like that of some species of *Cassia—C. lignitum, C. ambigua*, Ung., for example.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Rhus Hilliæ, sp. nov.

Plate XLI, Figs. 12-15.

Leaves irregularly pinnately divided; terminal leaflets large, pyramidal, more or less rapidly narrowed to the base, deeply irregularly dentate; lateral pinnules small, nearly at right angles, ovate, acute, dentate, alternate or opposite, subdecurrent, sessile.

These leaves, which seem to have been compound and odd-pinnate, are represented in the fossil state merely by the terminal pinnules and one or two of the lateral ones attached to one side of their base, figs. 13, 14, or one pair opposite and sessile on the rachis at a distance from the terminal pinnule, fig. 12. The nervation is distinct. As seen in fig. 13, the secondary nerves are very oblique, straight, with intermediate shorter tertiary veins and nervilles at right angles.

The species is comparable to *Rhus incisa*, Sap., "Ét.," iii, 1, p. 111, pl. ii, fig. 4, which is made of a single small leaflet similar to fig. 15 of our plate.

Hab.—Florissant. Fragments and pinnules of this species have been seen in all the collections made by Mrs. *Hill.*

Rhus acuminata, Lesqx.

Plate XLII, Figs. 14-17.

Lesqx., Suppl. to Hayden's "Ann. Rep.," 1871, p. 8.

Leaflets narrowly ovate, lanceolate, acuminate; borders deeply dentate from near the base; lateral nerves open, joining the midrib nearly at right angles, much curved, craspedodrome.

These leaflets have great analogy of character with the terminal leaflets of *Weinmannia* as seen in pl. xlii, fig. 3. They cannot be referred to this genus, however, as they are contracted at base to a narrow not winged petiole. Their relationship also, considering them as mere leaflets either terminal or lateral, is with the preceding species, being by their shape, the teeth of the borders and the nervation, intermediate between this and

the following species. The secondary veins are close, parallel, with intermediate shorter tertiary veins of the same character as in *R. Hilliæ*.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

The specimen described in Suppl. to "Annual Report," 1871, is from Green River.

Rhus subrhomboidalis, sp. nov.

Plate XLI, Figs. 16–19.

Leaflets membranaceous, ovate or sub-rhomboidal, rounded to a short petiole, deeply dentate, acuminate; lateral nerves curved, craspedodrome.

Though these three leaflets are so much alike in their forms that it is not possible to refer them to two species, their nervation is very different on account of the position of the large teeth, one or two on each side. In fig. 19 the teeth are in the upper part of the leaflet and the lateral veins curve upward to reach them, and are distant from the upper more open parallel ones; in the other leaflets, figs. 17 and 18, the two pairs of teeth being lower, the lateral nerves are merely curved in their direction toward them and parallel from the base. It is not possible to decide whether these leaflets pertain to pinnate or to trifoliate leaves, like those of the common and so very variable *R. aromatica*. Their relation to those described by Saporta as *R. rhomboidalis*, "Ét.," iii, 111, p. 206, pl. xvi, figs. 2, 3, is remarkably close.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden,* and also in the Collection of the Princeton Museum, Nos. 751 and 832.

Rhus vexans, sp. nov.

Plate XLI, Fig. 20.

Leaves trifoliate, long-petioled; leaflets cuneiform, enlarged, obtusely dentate or lobate in the upper part and there abruptly narrowed to an obtuse apex; nervation mixed.

This small leaf is so exactly similar to a variety of *R. aromatica* (*R. trilobata*, Nutt.), especially found living in Texas, that it is scarcely possible to find any point of difference. In the living species the terminal upper lobes of the pinnules are more distinctly dentate, but its smaller leaves, of the same size as the one figured, have exactly the same subdivisions. The nervation is also the same, the lower lateral veins being camptodrome, the

upper entering the teeth or lobes, all being obliquely short branched. The relationship is also marked with the preceding species, which evidently pertains to that peculiar and variable type of *R. aromatica* which is still universally distributed in innumerable varieties through the North American continent from the 30° to the 43° of latitude.

Hab.—Florissant. Princeton Museum, No. 718.

Rhus trifolioides, sp. nov.

Leaves trilobate; leaflets oval; the medial slightly obovate and a little longer, narrowed to a short petiole; the lateral sessile, all apiculate and dentate to the middle.

The medial leaflet is 2½ centimeters long, 12 millimeters broad in the middle, the lateral ones 2 centimeters long and 1 broad, not as distinctly dentate as the middle. The teeth are sharp, turned exactly to the outside. The leaf is comparable to *R. Napæarum*, Ung., "Syllog.," i, p. 43, pl. xx, fig. 11, differing by the form of the oval sharply dentate leaflets. The pedicel is broken 1 centimeter below the base of the leaflets, the nervation indistinct.

Hab.—Florissant. Lacoè's Collection, No. 58.

Rhus rosæfolia, Lesqx.

"U. S. Geol. Rep.," vii, p. 293, pl. xlii, figs. 7–9.

ZANTHOXYLEÆ.

ZANTHOXYLON, Linn.

Zanthoxylon spireæfolium, sp. nov.

Plate XL, Figs. 1–3.

Leaves odd-pinnate; leaflets ovate, acute, or blunt at the apex, obscurely serrate, short-petioled; secondary nerves at an acute angle of divergence, parallel, simple or forking, camptodrome.

The leaflets vary from 1½ to 2½ centimeters long and from 7 to 14 millimeters broad; the lateral nerves appear craspedodrome in fig. 1. But in figs. 2, 3, where the veins are more distinct, they are seen joined to the teeth by nervilles and camptodrome.

This species is closely allied to *Z. juglandinum* and *Z. serratum*, Heer, represented "Fl. Tert. Helv.," pl. cliv, figs. 36 and 37. Upon the leaf,

fig. 2, there is a small fruit of *Sapindus* (enlarged, fig. 2*a*), comparable to that of *S. rubiginosus*, figured in Ung., "Syllog.," i, p. 34, pl. xv, fig. 10.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

AILANTHUS, Desf.

"U. S. Geol. Rep.," vii, p. 294.

Ailanthus longe-petiolata, sp. nov.

Plate XL, Figs. 6, 7.

Leaflets subcoriaceous, narrowly ovate-lanceolate, gradually acuminate, rounded in narrowing to a long petiole, irregularly obtusely dentate; secondary nerves close, open, curving near the borders or entering the teeth; tertiary nerves thinner, nearly as long as the secondary; nervilles at right angles.

The leaflets, 10 centimeters long and 3 broad in the middle, are a little smaller than those of *Ailanthus driandroides*, Heer, "Fl. Tert. Helv.," pl. cxxvii, fig. 32, which has the same form and an analogous nervation. In the American leaf most of the secondary nerves seem to enter the teeth or to run to the borders; but in the upper part of the leaves, where the borders are more distinct, the nerves are evidently camptodrome. It is a mixed nervation, same as seen upon the leaflet of Heer, *l. c.* The leaf however represents a different species, the teeth being obtuse and the petiole very long, too long for a leaflet of *Ailanthus*, except if it should represent a terminal one. The lower or basilar tooth on the leaflet is protruding outside and apparently glandulose, a peculiar character of *A. glandulosa* so generally cultivated now. Fig. 7 may not represent the fruit of the same species, though I have not seen any other leaf from the same locality which could be referred to this genus. The *samara* is equally winged on both sides of the seed, oblong, obtuse at both ends, slightly constricted in the middle. The fruit has a close affinity to that of *Ailanthus recognita*, Sap., "Ét.," i, p. 105, pl. viii, fig. 7.

Hab.—Randolph Co., Wyoming. U. S. Geol. Expl. Dr. *F. V. Hayden.*

MYRTACEÆ.

"U. S. Geol. Rep.," vii, p. 296.

EUCALYPTUS, Heer.

Eucalyptus Americana, Lesqx.

Ibid., p. 296, pl. lix, figs. 11, 12.

ROSIFLOREÆ.

AMELANCHIER, Medic.

Amelanchier typica, sp. nov.

Plate XL, Fig. 11.

Leaves submembranaceous, petioled, ovate, acute, serrate; nervation camptodrome.

This leaf seems to represent the living *A. Canadensis* in its more common or typical form, differing in nothing except the rounded base of the leaf, which is generally slightly cordate in the living species. I say generally, for some of its leaves are also rounded just as in the fossil form. The leaf, 8 centimeters long, 4 centimeters broad in the middle, has a petiole 2 centimeters long. The nervation is similar, the lateral nerves being only a little more distant. The average number of secondary nerves in leaves of *Amelanchier Canadensis* is 8 to 11, while the fossil leaf has only 9. But often large leaves of the living species have no more than 9.

Hab.—Florissant. Princeton Museum, No. 691.

CRATÆGUS, Linn.

Cratægus acerifolia, sp. nov.

Plate XXXVI, Fig. 10.

Leaf petioled, lanceolate in outline, deeply lobate, irregularly dentate; lobes lanceolate, acuminate; nervation craspedodrome.

The substance of the leaf is thickish, but not coriaceous; the leaf is gradually narrowed to the petiole, single-lobed on one side, the lobe being longer, and twice-lobed on the other side, where the lobes are shorter—all irregularly dentate. The secondary nerves are all craspedodrome, entering the lobes and the teeth; but their divisions, at least near the points of the lobes, are camptodrome, the borders being nearly entire.

This leaf has the facies of an *Acer*. I find nothing in the fossil plants described by authors to which it may be compared.

Hab.—Florissant. Princeton Museum, No. 660.

ROSA, Linn.

Rosa Hilliæ, sp. nov.

Plate XL, Figs. 16, 17.

Leaves small; leaflets oval, obtuse or short-pointed, serrate; stipules large, lanceolate, acuminate; nervation camptodrome.

These beautiful small leaves represent this genus more distinctly than any of the other fossil leaves which as yet have been referred to it. The leaflets are rather obtuse, the lateral much smaller, 5 to 15 millimeters long, 3 to 7 millimeters broad—all short-pediceled like the terminal ones; the nervation is camptodrome, the figure shows it mostly craspedodrome, a mistake evidently, for as seen on the left side of the largest pinnule, fig. 16, the veins are curved. The nervation near the borders is not quite distinct on the specimens.

Hab.—Florissant. Princeton Museum, No. 768. Also in the collection of the U. S. Geol. Expl. by Dr. *F. V. Hayden.*

AMYGDALUS, Linn.

Amygdalus gracilis, sp. nov.

Plate XL, Figs. 12–15; XLIV, Fig. 6.

Leaves ovate-lanceolate, gradually narrowed to the acuminate point and in the same degree to the petiole, serrulate; lateral nerves at a more or less acute angle of divergence, much curved, camptodrome and reticulate along the borders.

These fine leaves of solid membranaceous tissue average 7 centimeters long and 2 broad, with a slender petiole about 2 centimeters long. They are more or less distinctly minutely serrate; the nerves, open at base and much curved toward the borders, are joined by undulate nervilles nearly at right angles.

Fig. 6 of pl. xliv is a leaf slightly longer acuminate, with obsolete nervilles, but without any important difference from the normal form.

The leaves are related to *A. pereger*, Ung., in Heer, "Fl. Tert. Helv.," iii, p. 95, pl. cxxxii, figs. 8–12. The fruits, figs. 14 and 15, appear to belong to this genus and possibly to this species. The reference is of course hypothetical.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.* Fig. 12 is from a specimen, No. 865, of the Princeton Museum. The specimen, fig. 6, is from Randolph County, Wyoming. Prof. *Scudder.*

LEGUMINOSÆ.

CYTISUS, Linn.

Cytisus modestus, sp. nov.

Plate XXXIX, Figs. 9, 10, 11.

Leaves trifoliate; leaflets sessile, ovate-lanceolate, acute, borders entire; secondary nerves camptodrome.

The small leaves, with leaflets 2 to 3 centimeters long, 5 to 8 millimeters broad, have the nervation mostly obsolete. I do not find them related to any fossil species published. Fig. 9 appears to have the borders serrulate, but that is probably caused by maceration and erosion. It has the same characters.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Cytisus Florissantianus, sp. nov.

Plate XXXIX, Fig. 14.

Leaf long-petioled; leaflets entire, ovate-lanceolate, the middle short-pedicellate, the lateral sessile, unequilateral at base; nervation camptodrome.

The leaflets appear acuminate, but the point is broken; they are rounded in narrowing to the base, and the borders are entire, only slightly undulate. This species is scarcely different from *C. Freybergensis*, Ung., "Syllog.," ii, p. 19, pl. iv, fig. 2, from which it merely differs by the leaflets being a little longer and narrower. The nervation is of the same type, and if the leaflets of the American leaf are obtuse the species should be considered as identical.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

DALBERGIA, Linn. fil.

Dalbergia cuneifolia, Heer.

Plate XXXIV, Figs. 6, 7.

Heer, "Fl. Tert. Helv.," iii, p 104, pl. cxxxiii, fig. 20.

Leaves pinnate; leaflets sessile, membranaceous, cuneate to the base, emarginate at the apex; secondary nerves thin, at an acute angle of divergence.

The leaves are small, averaging 3 centimeters long, 1½ broad near the middle, from which they are gradually narrowed to the somewhat enlarged point of attachment. The lateral nerves are at an acute angle of diverg-

ence of 40° on the right side, a little more open on the left, ascending high and reticulate along the borders; the areolation is formed of nervilles at right angles, forking or anastomosing in the middle of the areas, rarely simple.

These leaves only differ from the one described by Heer under this name in their slightly larger size and in the apex being a little more deeply emarginate. The nervation is peculiar and evidently of the same type as in the European leaves, where the lateral nerves are, however, somewhat obsolete. The secondary nerves, four pairs, are distant, alternate, the upper pairs curving inward toward the apex of the midrib.

Hab.—Florissant. Princeton Museum, Nos. 790, 791.

CERCIS, Linn.

Cercis parvifolia, sp. nov.

Plate XXXI, Figs. 5–7.

Leaves small, membranaceous, round or subtruncate at base, broadly cuneate to the slightly-pointed apex, very entire, five-nerved at base; medial nerve slightly stronger, secondary nerves camptodrome.

The three leaves figured and a few others seen in the shale of Florissant are small comparatively to those of this genus described as fossil. They are equilateral, enlarged, and truncate or subcordate at base; the basilar nerves are at right angles; the lateral at an angle of divergence of 30° to 40° are camptodrome like their divisions. The reticulation is obsolete. None of the few fossil species of this genus are comparable to this. The leaves vary from 1½ to 3 centimeters in width, being as long as broad.

Hab.—Florissant. Princeton Museum, Nos. 766, 767, Figs. 5 and 6; the other from the U. S. Geol. Expl. Dr. *F. V. Hayden.*

PODOGONIUM, Heer.

'U. S. Geol. Rep.," vii, p. 298.

Podogonium acuminatum, sp. nov.

Plate XL, Fig. 9.

Leaflets sessile, subcoriaceous, very entire, oblong, obtusely acuminate, narrowed to a short petiole, slightly unequilateral at base; lateral nerves close together, very open or nearly at right angles to the midrib, curved, camptodrome; tertiary nerves parallel, as long as the secondary, thin.

The small leaflet, a little more than 4 centimeters long and 1 broad, has the peculiar nervation of species of this genus, especially like that of *P. latifolium*, Heer, "Fl. Tert. Helv.," pl. cxxxvi, figs. 10–21. The form of the leaflet, contracted near the apex into a short obtuse acumen, is different from any of the European species. A fragment only of a seed referable to this genus has been found, probably at the same locality, being labeled Middle Park, a name often used for leaves from Florissant.

Hab.—Florissant. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Podogonium Americanum, Lesqx.

"U. S Geol. Rep.," vii, p. 298, pl. lix, fig. 5; lxiii, fig 2; lxv, fig. 6.

CASSIA, Linn.

Cassia Fischeri, Heer.

"Fl. Tert. Helv.," iii, p. 119, pl. cxxxvii, figs. 62–65.

Leaflets membranaceous, petioled, ovate-lanceolate, acuminate; secondary nerves at an acute angle of divergence.

These leaves, with the shape, size, and nervation of this species, are acuminate, like fig. 64 of Heer.

Hab.—Florissant. Lacoe's Collection, No. 42.

LEGUMINOSITES.

Leguminosites serrulatus, sp. nov.

Plate XXXIX. Figs. 7, 8.

Leaves trifoliate, long-petioled, membranaceous; leaflets narrowly lanceolate, sessile, and serrulate; secondary nerves obsolete.

The leaflets are long and narrow, the lateral a little shorter than the terminal, largest in the middle, tapering upward, acuminate or pointed and gradually narrowed to the base. The relationship of these leaves is unknown to me.

Hab.—Florissant. Princeton Museum, Nos. 784 and 785.

Leguminosites alternans, Lesqx.

Hayden's "Ann. Rep.," 1874, p. 315.

Leguminosites cassioides, Lesqx.

"U. S Geol. Rep.," vii, p. 300, pl. lix, figs. 1-4.

Leguminosites species.

Plate XXXIX, Figs. 16, 17.

Pistillate ovaries and stamens of *Leguminosæ*.

Hab.—Florissant. Seen in divers collections.

ACACIA, Neck.

Acacia septentrionalis, Lesqx.

Plate XXXIX, Fig. 15 (15*a* enlarged).

"U. S. Geol. Rep.," vii, p. 299, pl. lix, fig. 9 (9*a* enlarged).

MIMOSITES, Lesqx.

Mimosites linearifolius, Lesqx.

Plate XXXVII, Figs. 10-13.

"U. S. Geol. Rep.," vii, p. 300, pl. lix, fig. 7.

INCERTÆ SEDIS.

Antholithes obtusilobus.

Plate XXXII, Fig. 20.

A monosepalous funnel-shaped perianth, cut to the middle in broad obtuse lobes, attached to the ovary; substance hard, membranaceous.

Hab.—Florissant. Princeton Museum, No. 856.

Antholithes amœnus, sp. nov.

Plate XXXIV, Figs 13-15.

A six-petaloid perianth, apparently mono[illegible]ous, with six stamens and one pistil distinctly preserved.

Hab.—Florissant. U. S. Geol. Ex[illegible] Dr. *F. V. Hayden.*

Antholithes improbus, sp. nov.

Plate XL, Figs. 20, 21.

Whorls of four coriaceous segments, open or reflexed, attached by a narrow base enlarged upward, fan-like and undulate-lobed on the borders.

These fragments might represent reflexed scales of conifers but the axis is too narrow. They are comparable to what Heer has named *Equisetum tunicatum*, "Fl. Tert. Helv.," p. 44, pl. xiv, fig. 10, which represents a broken sheath of *Equisetum*.

Hab.—Randolph Co., Wyoming. U. S. Geol. Expl. Dr. *F. V. Hayden.*

Carpites gemmaceus, sp. nov.

Plate XL, Fig. 19.

Fruits or buds oval, obtuse, short-pediceled in three at the top of a small branchlet. They are striate in the length, like unopened buds of flowers.

Hab.—Florissant. Princeton Museum, No. 854.

Carpites Milioides, sp. nov.

Plate XL, Fig. 18.

Seeds on slender pedicels, diffusely panicled, oval, thinly striate lengthwise, 3 millimeters long, 2 broad.

Resembles a panicel of *Milium effusum*, Linn. The seeds are flattened.

Hab.—Florissant. Princeton Museum.

GENERAL REMARKS.

The number of species enumerated and described from this group is 228; of these Florissant has the largest number (152), while from the Green River Station 24 species only have been determined from specimens obtained in a cut of the railroad just above the station, and which, of course, represent the Flora of the Green River Group. Of the other localities, I have found 15 species in the specimens from Elko, 14 in those from Randolph County, Wyoming, 7 in those from Alkali Station, 6 in those obtained near the mouth of the White River, and of the other localities marked in the table two or three only in each.

With these materials it is not well possible to determine, from a comparison of the plants of each place, the degree of relation of the local vegetable groups, and, therefore, a table of distribution does not seem of great value for that purpose. It is, however, important to record the data, which may help to trace the march of the vegetation on the American continent during the Tertiary; to see also if the different localities, which I formerly referred to the same stage, show traces of identity in the characters of their plants and at the same time to fix, if possible, the age of the very interesting vegetable group of Florissant by its affinity with some local Flora of Europe. And as this volume is, most probably, the last which I shall have opportunity to prepare on Tertiary plants of Western America, I think proper to leave all the materials which have been examined thus far, exposed as clearly as possible for future comparison.

TABLE OF DISTRIBUTION OF THE PLANTS OF THE GREEN RIVER AND WHITE RIVER GROUPS.

NAMES OF SPECIES.	Florissant, Elko, Henry's Fork.	Green River Station, White River, Randolph County.	Alkali Station, Rock Creek.	Sage Creek, Barrell's Springs.	AMERICAN.		EUROPEAN.						Recent.
					Eocene.	Miocene.	Oligocene.			Miocene.			
						Greenland and Arctic, Alaska, Carbon, Union Group, etc.	Gypses of Aix.	Häring and Sotzka.	Bornstädt.	Fl. Helv.	Œningen.	Bilin.	
CRYPTOGAMEÆ.													
Fungi.													
Sphæria Myricæ, Lx		G. R.											
Characeæ.													
Chara ? glomerata, Lx	Fl.												
Musci.													
Fontinalis pristina, Lx	Fl.												
Hypnum Haydenii, Lx	Fl.												
Rhizocarpeæ.													
Salvinia cyclophylla, Lx	Fl.											Rel.	
Salvinia Alleni, Lx	Fl.									Rel.			
Lycopodiaceæ.													
Lycopodium prominens, Lx	Fl.												
Equisetaceæ.													
Equisetum Haydenii, Lx				B. S.									
Equisetum Wyomingense, Lx		G. R.											
Isoetiæ.													
Isoetes brevifolia, Lx	Fl.									Rel.			
Filices.													
Sphenopteris Guyottii, Lx	Fl.					Spitz. Rel.							
Adiantites gracillimus, Lx	Fl.							Sotz.					
Lastræa(Goniopteris)intermed.,Lx	H. F.									Id?		Id?	
Pteris pseudo-pennæformis, Lx	H. F.									Id?		Id?	
Diplazium Muelleri, Hr	H. F.								Id.				
Lygodium neuropteroides, Lx				B. S.									
Lygodium Dentoni, Lx		W. R.					Rel.						
Coniferæ.													
Pinus Florissanti, Lx	Fl.												
Pinus palæostrobus ?, Ett.	Fl.							Hä.					
Sequoia affinis, Lx	Fl.						Rel.				Mioc.	Rel.	
Sequoia angustifolia, Lx	El.					Al., Id.							
Sequoia Heerii, Lx				S. C.									
Sequoia Langsdorfii, Brgt.	Fl.					A., Car., Id.				Id.			
Taxodium distichum miocen., Hr.	El.					Car., Id.				Id.			
Widdringtonia linguæfolia, Lx	Fl.						Rel.						
Thuya Garmani, Lx	El.												
Glyptostrobus Ungeri ?, Hr	Fl.					Id.	Rel.			Id.		Id.	
Podocarpus eocenica ?, Hr	Fl.							Id.					

Table of Distribution of the Plants of the Green River and White River Groups—Continued.

NAMES OF SPECIES.	Florissant, Elk's, Henry's Fork.	Green River Station, White River, Randolph County.	Alkali Station, Rock Creek.	Sage River, Barrell's Springs.	AMERICAN.		EUROPEAN.						Recent.
					Eocene.	Miocene.	Oligocene.			Miocene.			
						Greenland and Arctic, Alaska, Carbon, Union Group, etc.	Gypses of Aix.	Häring and Sotzka.	Bornstädt.	Fl. Helv.	Œhningen.	Bilin.	
MONOCOTYLEDONES.													
GRAMINEÆ.													
Poacites lævis, Hr				B. S						Id			
Cyperus Chavannesi, Hr		G. R.								Id			
Cyperites Haydenii, Lx		R											
Arundo Gœpperti?, U		G. R.								Id			
Arundo reperta, Lx		G. R.											Rel.
Phragmites Alaskana, Hr		G. R.				Al., Id.				Rel.			
TYPHACEÆ.													
Typha latissima, Al. Br.	Fl.	R								Id.			
Potamogeton verticillatus, Lx	Fl.						Rel.						
Potamogeton geniculatus, Al. Br.	Fl.									Id.			
Najadopsis rugulosa, Lx	Fl.												
MUSACEÆ.													
Musophyllum complicatum, Lx		G. R.											
AROIDEÆ.													
Acorus brachystachys, Lx	Fl.					Spitz., &c., Id.							
LEMNACEÆ.													
Lemna penicillata, Lx	Fl.												Rel.
PALMÆ.													
Flabellaria Florissanti, Lx		R			Rel		Rel.						
Palmocarpon? globosum, Lx	Fl.				Rel								
DYCOTYLEDONES.													
MYRICACEÆ.													
Myrica Copeana, Lx	El.									Rel.			
Myrica obscura, Lx	Fl.									Rel.			
Myrica Ludwigii, Schp		W.R.										Id.	
Myrica acuminata, U	Fl.	W.R.						Id.					
Myrica rigida, Lx	Fl.	W.R.						Rel.					
Myrica zachariensis, Sap	Fl.						Id.						
Myrica polymorpha, Schp	Fl.						Id.						
Myrica callicomæfolia, Lx	Fl.,E.						Rel.						
Myrica fallax, Lx	Fl.						Rel.						
Myrica Scottii, Lx	Fl.									Rel.			
Myrica amygdalina, Sap	Fl.						Id.						
Myrica nigricans, Lx		G. R.											Rel.
Myrica Bolanderi, Lx	Fl.												
Myrica undulata, Hr	El.									Id.			
Myrica partita, Lx	El.										Rel.		
Myrica Brongniarti?, Ett.	El.										Id.		
Myrica diversifolia, Lx	Fl.							Rel.					
Myrica latiloba, Hr., var. acutiloba	Fl.					Id				Id.			

Table of Distribution of the Plants of the Green River and White River Groups—Continued.

NAMES OF SPECIES.	Florissant, Elko, Henry's Fork.	Green River Station, White River, Randolph County.	Alkali Station, Rock Creek.	Sage Creek, Barrell's Springs.	AMERICAN.		EUROPEAN.						Recent.
					Eocene.	Miocene.	Oligocene.			Miocene.			
						Greenland and Arctic, Alaska, Carbon, Union Group, etc.	Gypses of Aix.	Hæring and Sotzka.	Bornstädt.	Fl. Helv.	Œningen.	Bilin.	
Myrica alkalina, Lx			Al							Rel			
Myrica insignis, Lx	Fl												
BETULACEÆ.													
Betula Florissanti, Lx	Fl												
Betula truncata, Lx	Fl										Rel		
Alnus Kefersteinii, Gœp	Fl	G. B.				Al.,etc.Id.					Id		
Alnus inæquilateralis, Lx			Al				Rel						
Alnus cordata, Lx	Fl											Rel	
CUPULIFERÆ.													
Ostrya betuloides, Lx	Fl						Rel						
Carpinus grandis, U	Fl,El					Mioc.,Id.				Id			
Carpinus attenuata, Lx	Fl										Rel		
Carpinus fraterna, Lx	Fl												Rel
Fagus feroniæ, U	El					Mioc.,Id.					Id		
Quercus Haidingeri, Ett		G. B.								Id			
Quercus Mediterranea, U	Fl									Id			
Quercus serra, U	Fl									Id			
Quercus drymeja, U		R				Mioc.,Id.		Id					
Quercus Osbornii, Lx	Fl							Rel					
Quercus pyrifolia, Lx	Fl						Rel						
Quercus castaneopsis, Lx		R											
Quercus elæna, U	Fl					Rel?	Id			Id			
Quercus neriifolia, Al. Br		R								Id			
Castanea intermedia, Lx	?					Rel?							Rel
SALICINEÆ.													
Salix amygdalæfolia, Lx	Fl										Rel		
Salix Libbeyi, Lx	Fl												
Salix media, Hr	El	G. B.											
Salix angusta, Al. Br		G. B.				Id					Id		
Salix elongata, Web	El										Id		
Populus Heerii, Sap	Fl						Id						Rel
Populus balsamoides, Gœp., var		R				Id				Id			Rel
Populus Zaddachi, Hr	Fl					Gr., Id.							
Populus oxyphylla, Sap	Fl						Id						
Populus Richardsoni, Hr	El					Gr., Id.				Id			
Populus arctica, Hr	?					Gr., Id.							
BALSAMIFLUÆ.													
Liquidambar Europæum, Al. Br		R				Mioc.,Id.				Id			
ULMACEÆ.													
Ulmus, tenuinervis, Lx	Fl									Rel			
Ulmus Hilliæ, Lx	Fl												
Ulmus Brownellii, Lx	Fl	W. B.											
Ulmus Braunii, Hr	Fl									Id			

Table of Distribution of the Plants of the Green River and White River Groups—Continued.

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					Eocene.	Miocene.	Oligocene.			Miocene.			
						Greenland and Arctic, Alaska, Carbon, Union Group, etc.	Gypsus of Aix.	Häring and Sotzka.	Bornstädt.	Fl. Helv.	Œningen.	Bilin.	Recent.
Planera longifolia, Lx., and var	Fl..El	W. R.								Rel.			
Planera Ungeri, Ett	Fl.					Mioc., Id.				Id.			
Celtis McCoshii, Lx	Fl.	R.					Rel.						
MOREÆ.													
Ficus lanceolata, Hr	Fl.									Id.			
Ficus Jynx, U	El.							Id.					
Ficus multinervis, Hr		G. R.						Id.					
Ficus arenacea, Lx		G. R.											
Ficus Ungeri, Lx		G. R.	Al.			Mioc., Id.							
Ficus Wyomingiana, Lx		G. R.											
Ficus tenuinervis, Lx			Al.										
Ficus alkalina, Lx			Al.										
SANTALEÆ.													
Santalum Americanum, Lx	Fl.												Rel.
LAURINEÆ.													
Cinnamomum Scheuchzeri, Hr		R.				Mioc., Id.					Id.		
PROTEACEÆ.													
Banksites lineatus, Lx	Fl.										Rel.		
Lomatia spinosa, Lx	Fl.												
Lomatia hakeæfolia, Lx	Fl.												
Lomatia terminalis, Lx	Fl.												
Lomatia tripartita, Lx	Fl.												
Lomatia acutiloba, Lx	Fl.												
Lomatia abbreviata, Lx	Fl.												
Lomatia interrupta, Lx	Fl.												
Lomatia microphylla, Lx		W. R.											
PIMELEÆ.					•								
Pimelea delicatula, Lx	Fl.											Rel.	
OLEACEÆ.													
Olea præmissa, Lx	Fl.												Rel.
Fraxinus prædicta, Hr	Fl.									Id.			
Fraxinus Heerii, Lx	Fl.									Rel.			
Fraxinus Mespilifolia, Lx	Fl.									Rel.			
Fraxinus abbreviata, Lx	Fl.						Rel.						
Fraxinus myricæfolia, Lx	Fl.												Rel.
Fraxinus Ungeri, Lx	Fl.										Rel.		
Fraxinus Brownellii, Lx			Al.										
Fraxinus Libbeyi, Lx	Fl.												
APOCYNEÆ.													
Apocynophyllum Scudderi, Lx	Fl.									Rel.			
CONVOLVULACEÆ.													
Porana Speirii, Lx	Fl.										Rel.		

Table of Distribution of the Plants of the Green River and White River Groups—Continued.

NAMES OF SPECIES.	Florissant, Elko, Henry's Fork.	Green River Station, White River, Randolph County.	Alkali Station, Rock Creek.	Sago Creek, Barrell's Springs.	AMERICAN.		EUROPEAN.						
					EOCENE.	MIOCENE.	OLIGOCENE.			MIOCENE.			
						Greenland and Arctic, Alaska, Carbon, Union Group, etc.	Gypses of Aix.	Häring and Sotzka.	Bornstädt.	Fl. Helv.	Œningen.	Bilin.	*Recent.*
Ilrana tenuis, Lx	Fl.										Rel.		
MYRSINEÆ.													
Myrsine latifolia, Lx	Fl.						Rel?						
SAPOTACEÆ.													
Bumelia Florissanti, Lx	Fl.						Rel?						
Diospyros brachysepala, Al. Br.	Fl.									Id.			
Diospyros Copeana, Lx	Fl., El.												
Macreightia crassa, Lx	Fl.									Rel.			
ERICACEÆ.													
Andromeda delicatula, Lx		R.								Rel.			
Andromeda rhomboidalis, Lx	Fl.									Rel.			
Vaccinium reticulatum?, Al. Br.	Fl.									Id.			
ARALIACEÆ.													
Aralia dissecta, Lx	Fl.						Rel.						
Hedera marginata, Lx	Fl.												
AMPELIDEÆ.													
Cissus parrotiæfolia, Lx		G. R.											
Ampelopsis tertiaria, Lx		G. R.											Rel.
SAXIFRAGEÆ.													
Weinmannia Haydenii, Lx	Fl.										Rel.		
Weinmannia integrifolia, Lx	Fl.												
Weinmannia obtusifolia, Lx	Fl.												
MALVACEÆ.													
Sterculia rigida, Lx	Fl.										Rel.		
TILIACEÆ.													
Tilia populifolia, Lx	Fl.												
ACERACEÆ.													
Acer æquidentatum, Lx		W. R.				Mioc., Id.					Rel.		
Acer indivisum, Lx		R.				Arct.							
Acer, species?	Fl.										Rel.		
SAPINDACEÆ.													
Sapindus stellariæfolius, Lx	Fl.												
Sapindus angustifolius, Lx	Fl.									Rel.			
Sapindus coriaceus, Lx	El.												
Sapindus Dentoni, Lx		W. R.								Rel.			
Sapindus obtusifolius, Lx	Fl.	G. R.				U. G., Mio., Id.							
Sapindus inflexus, Lx	Fl.									Rel.			
Sapindus lancifolius, Lx		R.						Rel.					
Dodonæa, species	Fl.											Rel.	
STAPHYLEACEÆ.													
Staphylea acuminata, Lx	Fl.												Rel.

Table of Distribution of the Plants of the Green River and White River Groups—Continued.

NAMES OF SPECIES.	Florissant, Elk's, Henry's Fork.	Green River Station, White River, Randolph County.	Alkali Station, Rock Creek.	Sage Creek, Burrell's Springs.	AMERICAN.		EUROPEAN.						
					Eocene.	Miocene.	Oligocene.			Miocene.			
						Greenland and Arctic, Alaska, Carbon, Union Group, etc.	Gypses of Aix.	Haering and Sotzka.	Bornstädt.	Fl. Helv.	Œningen.	Bilin.	Recent.
FRANGULACEÆ.													
Evonymus flexifolius, Lx		R										Rel	
Celastrus Lacoei, Lx	Fl									Rel			
Celastrus Greithianus, Hr	Fl									Id			
Celastrus fraxinifolius, Lx	Fl												
Celastrinites elegans, Lx	Fl												
ILICEÆ.													
Ilex pseudo-stenophylla, Lx	Fl										Rel		
Ilex microphylla, Lx	Fl										Rel		
Ilex maculata, Lx			Al										
Ilex Wyomingiana, Lx		G. R								Rel			
Ilex affinis, Lx		G. R								Rel			
Ilex subdenticulata, Lx	Fl									Rel			
Ilex dissimilis, Lx				S. Cr									
Ilex quercifolia, Lx	Fl						Rel						
Ilex grandifolia, Lx	Fl												
Ilex Knightiæfolia, Lx	Fl												
RHAMNEÆ.													
Paliurus Florissanti, Lx	Fl												Rel
Paliurus orbiculatus, Sap	Fl						Id						
Zizyphus cinnamomoides, Lx		G. R								Rel			
Rhamnus oleæfolius, Lx	Fl				Rel								
Rhamnus notatus?, Sap	Fl						Id						
JUGLANDEÆ.													
Juglans Schimperi, Lx		G. R			Id								
Juglans denticulata, Hr		G. R				Mioc., Id				Rel			
Juglans Florissanti, Lx	Fl									Rel			
Juglans Alkalina, Lx			Al										
Juglans costata, U	Fl									Id			
Carya bilinica, U	Fl									Id			
Carya rostrata, Schp	Fl									Id			
Carya Bruckmanni, Hr	Fl									Id			
Pterocarya Americana, Lx	Fl?									Rel			
Engelhardtia oxyptera, Sap	Fl						Id						
ANACARDIACEÆ.													
Rhus fraterna, Lx	Fl						Rel						
Rhus coriarioides, Lx	Fl												Rel
Rhus cassioides, Lx	Fl												
Rhus Hilliæ, Lx	Fl						Rel						
Rhus acuminata, Lx	Fl	G. R					Rel						
Rhus subrhomboidalis, Lx	Fl						Rel						
Rhus vexans, Lx	Fl												Id
Rhus trifolioides, Lx	Fl									Rel			
Rhus rosæfolia, Lx	Fl												

Table of Distribution of the Plants of the Green River and White River Groups—Continued.

NAMES OF SPECIES.	Florissant, Elko, Henry's Fork.	Green River Station, White River, Randolph County.	Alkali Station, Rock Creek.	Sage Creek, Barrell's Springs.	AMERICAN.		EUROPEAN.						Recent.
					Eocene.	Miocene.	Oligocene.			Miocene.			
						Greenland and Arctic, Alaska, Carbon, Union Group, etc.	Gypses of Aix.	Hæring and Sotzka.	Bornstädt.	Fl. Helv.	Ettingen.	Bilin.	
ZANTHOXYLEÆ.													
Zanthoxylon spireæfolium, Lx	Fl									Rel			
Ailanthus longe-petiolata, Lx		R					Rel						Rel
Eucalyptus? Americana, Lx		G. R											
ROSIFLORÆ.													
Amelanchier typica, Lx	Fl												Rel
Cratægus acerifolia, Lx	Fl												
Rosa Hilliæ, Lx	Fl												Rel
Amygdalus gracilis, Lx	Fl	R								Rel			
LEGUMINOSÆ.													
Cytisus modestus, Lx	Fl												
Cytisus Florissantianus, Lx	Fl										Rel		
Dalbergia cuneifolia, Hr	Fl									Id			
Cercis parvifolia, Lx	Fl						Rel						
Podogonium acuminatum, Lx	Fl										Rel		
Podogonium Americanum, Lx	Fl												
Cassia Fischeri, Hr	Fl									Id			
Leguminosites serrulatus, Lx	Fl												
Leguminosites alternans, Lx		W. R											
Leguminosites cassioides, Lx		G. R									Rel		
Leguminosites, species	Fl												
Acacia septentrionalis, Lx	Fl												
Mimosites linearifolius, Lx	Fl												
INCERTÆ SEDIS.													
Antholithes obtusilobus, Lx	Fl												
Antholithes amænus, Lx	Fl												
Antholithes improbus, Lx	Fl												
Carpites gemmaceus, Lx	Fl												
Carpites milioides, Lx	Fl												Rel

RELATIONSHIP OF THE LOCAL GROUPS INDICATED BY CORRELATION OF SPECIES.

To consider the degree of relationship indicated by the groups of plants from the localities which I formerly referred to the Green River Group, I first put in apposition the Flora of the Green River Station and that of Florissant, for the specimens have been derived, at each place, from a limited area, and the floras of both are represented by the largest number of species.

Between these two groups of plants there are only two identical species: *Alnus Kefersteinii* and *Sapindus obtusifolius*. The first is one of the most common species of the European Miocene, and not less frequently found in that of North America in California, Oregon, Alaska, and in the Arctic flora of Greenland, Sachalin, &c. It is therefore a Miocene type of a wide distribution, and not a leading plant of a peculiar geological stage. The second species, *Sapindus obtusifolius*, is most abundant nine miles southeast of Green River Station, at a locality high in the hills, where a thin bed of coal is overlaid with sandy yellow shale filled with the remains of *Musophyllum complicatum* and *Sapindus obtusifolius*, mostly; for no other plants were obtained there except a single leaf of *Alnus Kefersteinii*. This species of *Sapindus* is so closely allied to *S. affinis*, Newby., of the Fort Union Group, that it may be considered a mere variety. The leaflets differ only by the more acute points in *S. affinis*, while in the specimens of Florissant the leaflets are more obtuse than in those of Green River, the difference being apparently local. These two species are therefore Miocene types. Then there are, from Green River Station, *Cyperus Chavannesi*, *Arundo Gœpperti*, *Phragmites alaskana*, *Quercus Haidingeri*, *Salix media*, *S. elongata*, *Juglans denticulata*, or seven European Miocene species. Of the others, *Equisetum wyomingense*, *Ilex affinis*, *I. wyomingiana* and a *Leguminosites* are closely allied to Miocene types, while *Ampelopsis tertiaria*, *Ficus Ungeri*, *Myrica nigricans*, *Arundo reperta* have their affinities to species living at our epoch. Hence 17 species out of 24 show evident relationship or identity with plants of the Miocene of Europe or with

some of the present epoch. The others, *Ficus arenacea*, *Zizyphus cinnamomoides*, *Cissus proteæfolia*, *Eucalyptus americana* are peculiar types whose affinity is not distinct. *Juglans Schimperi* is also represented in the Eocene of Golden, and *Ficus wyomingiana* at Evanston. Therefore there is nothing in this group of plants proving a relation to that of Florissant. From the beginning of my researches I have been uncertain about the geological relations of this flora. It is clear that from its character as exposed by the few materials I have had for identification, I could but refer it to the upper Miocene.

The same may be said of the 14 species obtained by Professor *S. H. Scudder* in Randolph County, Wyoming. Eight species, *Flabellaria Florissanti*, 3 species of *Quercus*, *Populus balsamoides*, *Liquidambar europæum*, *Cinnamomum Scheuchzeri*, *Zanthoxylum spireæfolium*, are identified in the Miocene of Europe. *Cyperites Haydenii*, *Acer indivisum*, *Celtis McCoshii*, *Evonimus flexifolius* are peculiar types; while one species only, *Amygdalus gracilis*, is represented at Florissant.

The flora of Elko Station, represented by 15 species, is more distinctly related to that of Florissant, with which it has four species in common—*Myrica callicomæfolia*, *Carpinus grandis*, *Planera longifolia*, *Diospyros Copeana*. Omitting *Carpinus grandis*, a common species of the Miocene of Europe and America, the three others are truly leading types of the flora of Florissant, where *Myrica callicomæfolia* and *Planera longifolia* are represented by hundreds of specimens; the other, *Diospyros Copeana*, has been found only at the two localities now compared. Of the other species of Elko, *Sapindus coriaceus* is related to *S. angustifolius* of Florissant; three species of Myrica and three Conifers of Elko indicate a predominance of plants of these genera, represented at Florissant by fourteen species of Myrica and seven Conifers. There is no relation whatever between the flora of Elko and that of the Eocene, or of a lower stage of the Tertiary; but five of its species, *Fagus Fernoniæ*, *Salix media*, *S. elongata*, *Populus Richardsoni*, and *Ficus Jynx* are identified in the Miocene of Europe, and one, *Lycopodium prominens*, is of a still more recent type.

Of the 9 known species of the White River flora, 4 are at Florissant, and these also are leading species—*Planera longifolia*, *Myrica acuminata*, *M. rigida*, and *M. longifolia*. A fifth, *M. Ludwigii*, is so intimately related

to the last that it has often been considered as a variety of it by authors; the type is the same. And then *Lygodium Dentoni* is related to a species of the Gypses of Aix; *Acer æquidentatum* has been described formerly from the upper Miocene of California; the others have their affinity with the Miocene of Europe.

Alkali Stage Station is only 15 miles from Green River Station. The horizon of both is geologically identical, and the Flora of the first, known by only 8 species, seems to confirm this determination, though all the species except *Ficus Ungeri* are peculiar to the locality. *F. Ungeri* has been first found at Green River Station; its affinity is with species living at this epoch and also with two other species of Alkali Station, *F. tenuinervis* and *F. alkalina*. *Myrica alkalina* is of Miocene type, related to *M. vindobonensis* and *M. Ungeri* of Heer; of the others, *Juglans alkalina* has the *facies* of leaves of *Juglandites* of Sézanne (Eocene); *Fraxinus Brownellii* is related to *F. juglandinus*, a type of the Gypses of Aix; *Ilex maculata*, from a leaf poorly preserved, and *Alnus inæquilateralis* are as yet without affinity known to me. The other localities whose Flora is known by two or three other species only do not demand consideration. The two species of Sage Creek are Miocene; of those of Barrell's Springs, *Equisiteum Haydenii* is identified at Carbon whose flora is Miocene; *Lygodium neuropteroides* is Eocene; *Poa lævis*, described in Hayden's "Ann. Rep.," 1871, from two fragmentary specimens, was not positively determined. The species is Miocene in Europe; as I found in the specimens of Barrell's Springs fragments of a Palm apparently identical with *Sabalites Zinkeni* of Golden, I have supposed the localities referable to the Laramie Group, or Eocene.

From the above it seems evident that the plants which I have heretofore referred to the Green River Group represent two different horizons: Green River Station, Randolph Co. and Alkali Station for one, Florissant, White River and Elko for a second. It may be possible to fix the horizon of this last group, or at least of Florissant, by comparison of its species with those of Europe. But for the present the materials obtained at Green River, Randolph Co., and Alkali Stations are too scant to afford any indication of their reference to any particular stage of the Tertiary; they may represent a lower group than that of Florissant, but what is said above of the relationship of these plants authorizes a contrary conclusion.

Of the 166 species of vegetable forms recognized in the specimens of Florissant, 50 are related to and 40 identical with Miocene species of Europe, while the affinity to the lower Tertiary, or Oligocene, of Germany is marked by 8 related and 4 identical species, and to the flora of the Gypses of Aix by 28 related and 16 identical species.

At first sight it seems that the types of the flora of Florissant are more distinctly Miocene, even upper Miocene, for two of its species represent plants living at the present time or which at least are so closely allied to them that it is scarcely possible to deny identity. But searching for more precise affinity, it will be remarked, first: that most of the species related to or identical with Miocene plants are species of wide distribution, which have been found in a large number of European localities from Italy to the Baltic, and on the American continent from Wyoming Territory and California to Oregon and Alaska; then to Greenland, Spitzbergen, Sachalin, &c. These plants have been described by a number of authors in different works; while the relationship to the flora of the Gypses of Aix refers to a single locality in the south of France, the plants of which have been described by one author only. Secondly, the more marked species, those represented by the largest number of specimens and which may be considered as peculiar to the group, are exclusively Oligocene—the mosses, the Rhizocarpeæ in two species of *Salvinia*, the Ferns, the Conifers with very few exceptions, the *Myricaceæ* especially, as numerous and as distinct in their types as they are in the flora of the Gypses of Aix, with which four of them are intimately related and five identical, the beautiful *Populus Heerii*, which, described by Saporta from a single leaf, is represented at Florissant by numerous fine specimens, the rare *Populus oxyphylla*, the abundant and varied species of *Lomatia* and of *Diospyros*, the large splendid leaf of *Aralia dissecta* very probably identical with *Aralia multifida*, Sap., species of *Ilex*, *Paliurus*, and especially peculiar forms of *Rhus*, also described in the "*Etudes*" of Saporta, give to the flora of Florissant a definite *facies* marking its analogy with the Oligocene far more distinctly than it is with the Miocene plants. This becomes evident in comparing the types of Florissant with those of the Miocene, published in this volume. In the "*Monde des Plantes*" Saporta enumerates as species, which he considers characteristic of the flora of the Gypses of Aix, *Aralia multifida, Cercis antiqua;* seeds

of *Ailanthus crispa;* involucres of *Palæocarya atavia, Betula gyspsicola, Quercus, salicina, Q. antecedens, Salix aquensis,* &c., all types which are recognized in the flora of Florissant by identical or closely allied species.

Besides the general characters of the flora, the peculiar compounds of the formation, the laminated shale mostly formed of ashes, the immense number of insects and fishes preserved in a succession of thin layers of grayish shale are repeated in the upper part of the Gypses of Aix precisely as they are found at Florissant. Says Saporta: Entire shoals of fishes were surprised and buried in the muddy clay of the bottom. Even insects suffocated in large numbers, from the smallest kind of mosquitoes to ants, bees, butterflies, are preserved in the thin shales with the minutest of their organs and even the colors of their wings. The borders of the lake also, like those of the Lake of Florissant, were deeply cut, and mountains of very steep slopes had their base raised up from the borders, even from the interior of the lake, &c. There was also, as at Florissant, a river traversing the lake in its whole length, hence the country was diversely broken and therefore afforded the best opportunity for a great diversity of its flora.

It cannot be surprising to find in the flora of Florissant such a large predominance of Miocene types, if, like that of Aix, it represents the last periods of the Eocene age, when of course the more predominant and permanent types of the Miocene were already represented.

The evidence of synchronism of the flora of Florissant with that of the Oligocene of France appears confirmed by the characters of the fauna. At least Professor Cope[1] identifies the White River Group with the Aquitanian and Tongrian of Europe—formations which close the Eocene or are partly referable to the Eocene, partly to the Miocene, and considers the Green River and the Wahsatch as Suessonian or Paleocene. This agrees with the observations of Saporta, who considers the Gypses of Aix as a long series of formations continuous through the different periods intervening between the Paleocene and the Miocene, the upper part even partaking of the character of this last epoch.

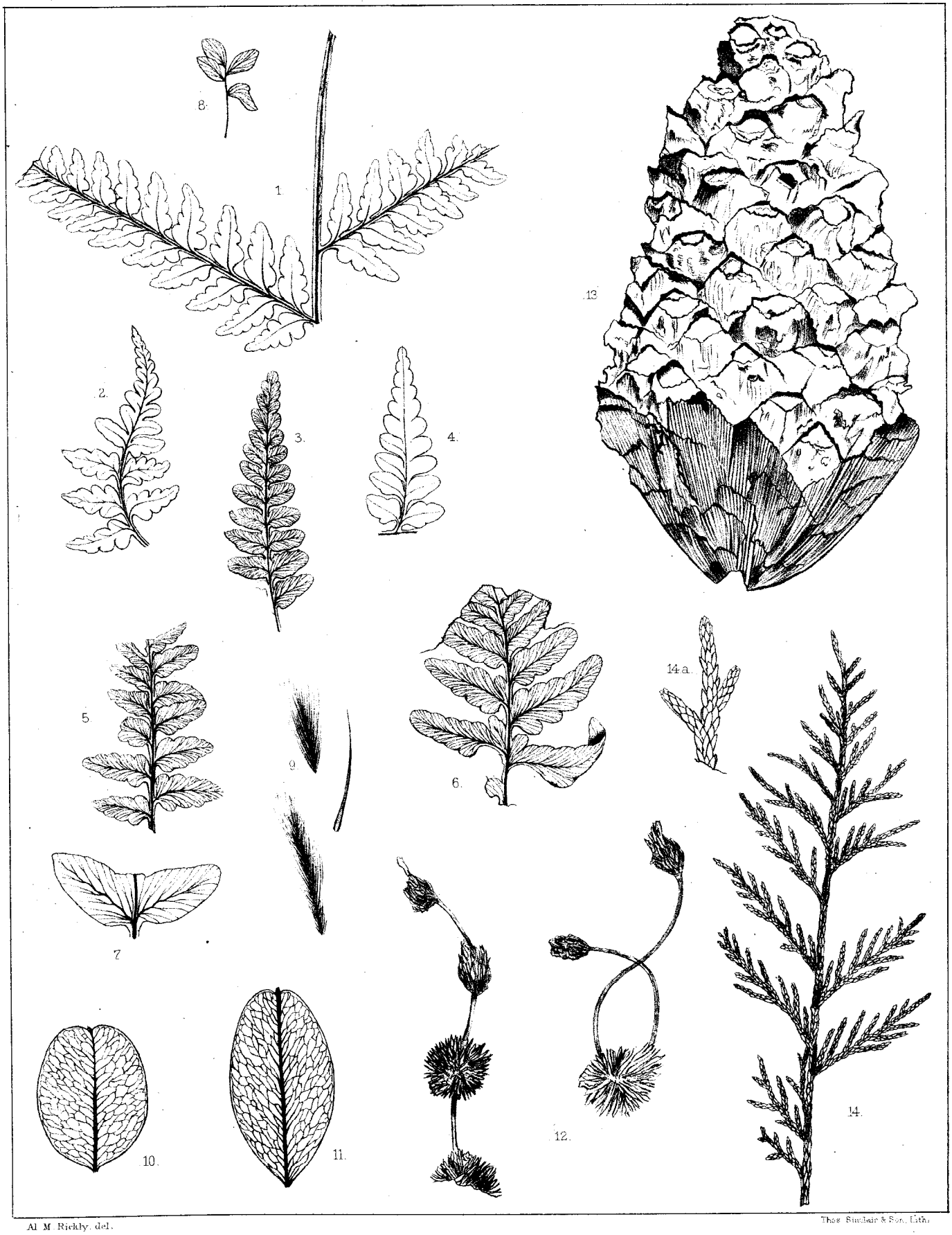
[1] The relations of the horizons of extinct vertebrata of Europe and North America, in "Bulletin of the U. S. Geol. and Geogr. Surveys," by Dr. F. V. Hayden, vol. v, No. 1.

Oligocene.

PLATE XXI.

Figures.

1, 7. Sphenopteris Guyottii, Lesqx., p. 137.
8. Adiantites gracillimus, Lesqx., p. 137.
9. Fontinalis pristina, Lesqx., p. 135.
10, 11. Salvinia Alleni, Lesqx., p. 136.
12. Chara? glomerata, Lesqx., p. 135.
13. Pinus Florissanti, Lesqx., p. 138.
14, 14*a*. Widdringtonia linguæfolia, Lesqx., p. 139.


8.
1.
13.
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9.
6.
14a.
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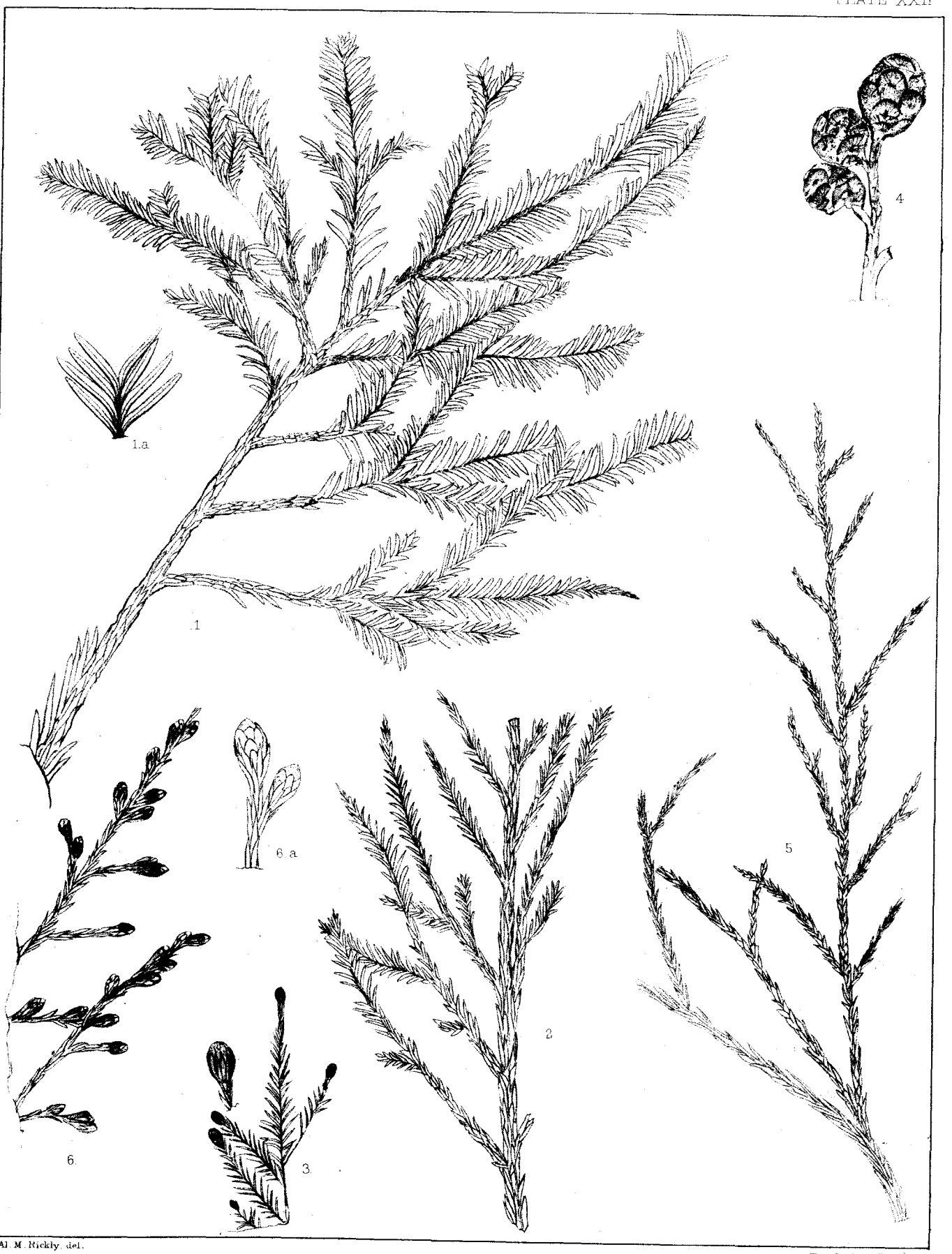
14.
10.
11.

Oligocene.

PLATE XXII.

Figures.

1–6. Glyptostrobus Ungeri, Heer, p. 139.


1.a
1
4
6.a
2
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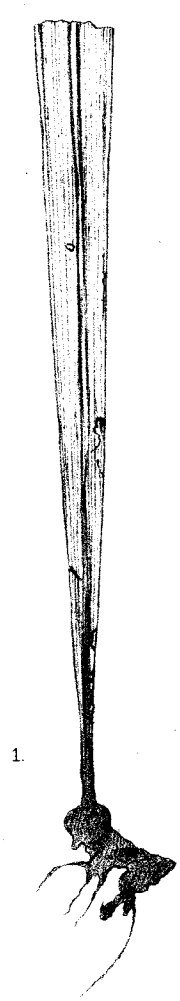
6
3

Oligocene.

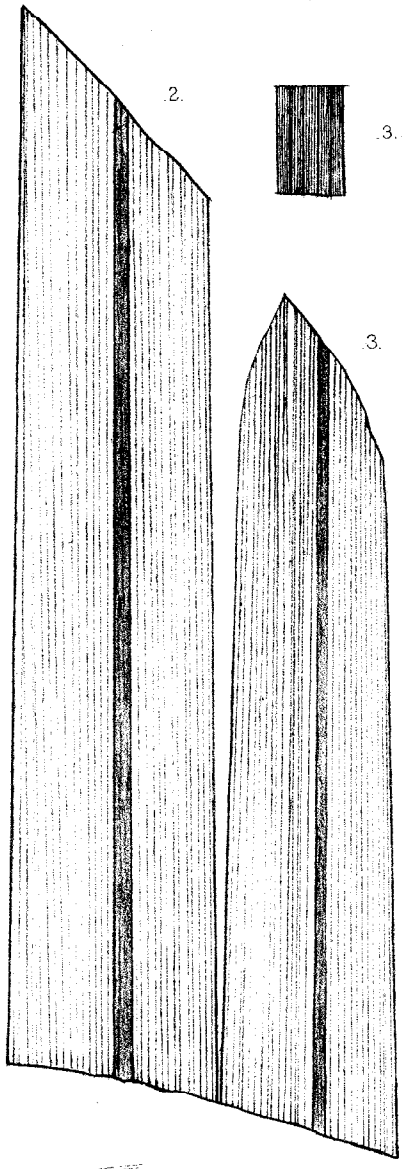
PLATE XXIII.

Figures.

1–3. Cyperites Haydenii, Lesqx., p. 140.
4, 4*a*. Typha latissima, Al. Br., p. 141.
5, 6. Potamogeton verticillatus, Lesqx., p. 142.
7. Najadopsis rugulosa, Lesqx., p. 142.
8. Lemna penicillata, Lesqx., p. 143.



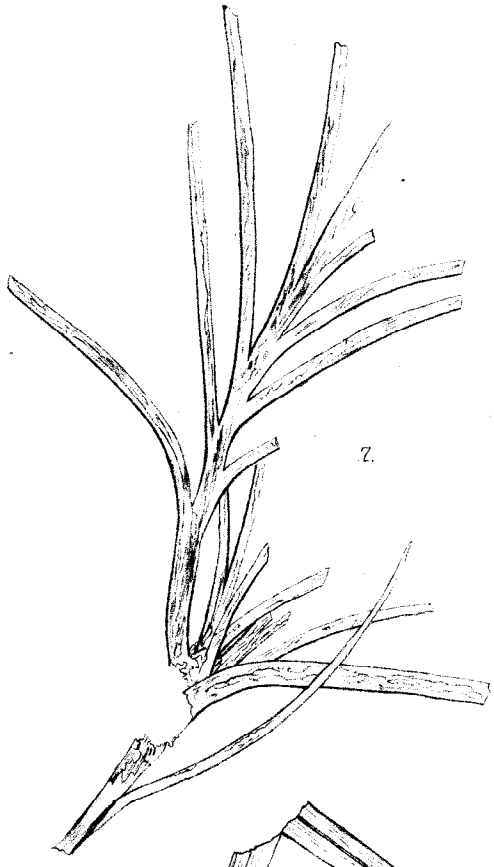
1.



2.

3.a.

3.



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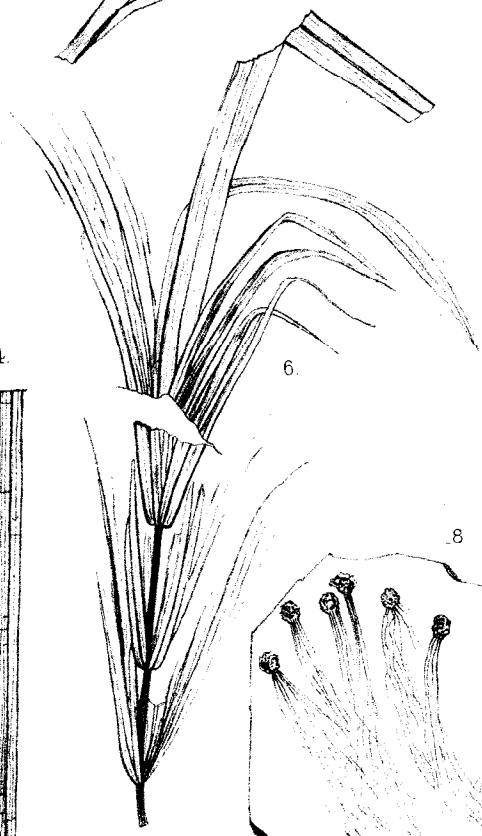

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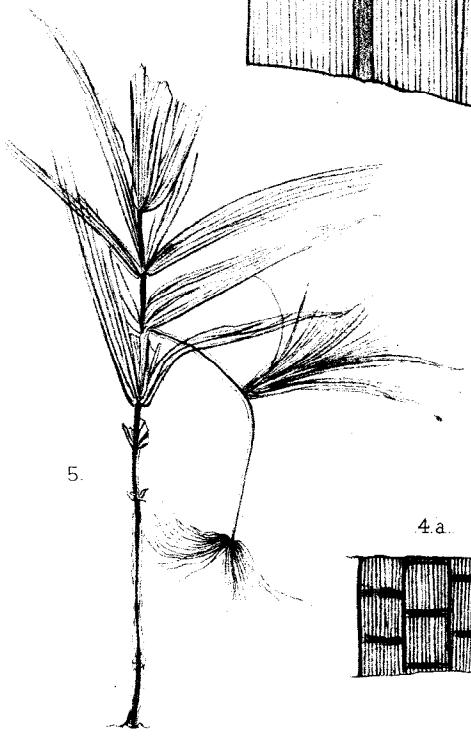

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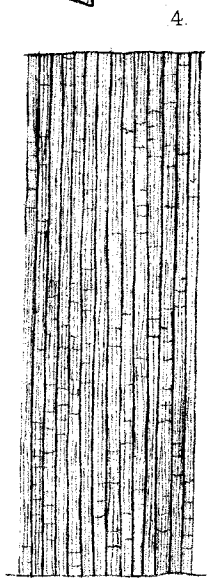


4.

4.a.

8.

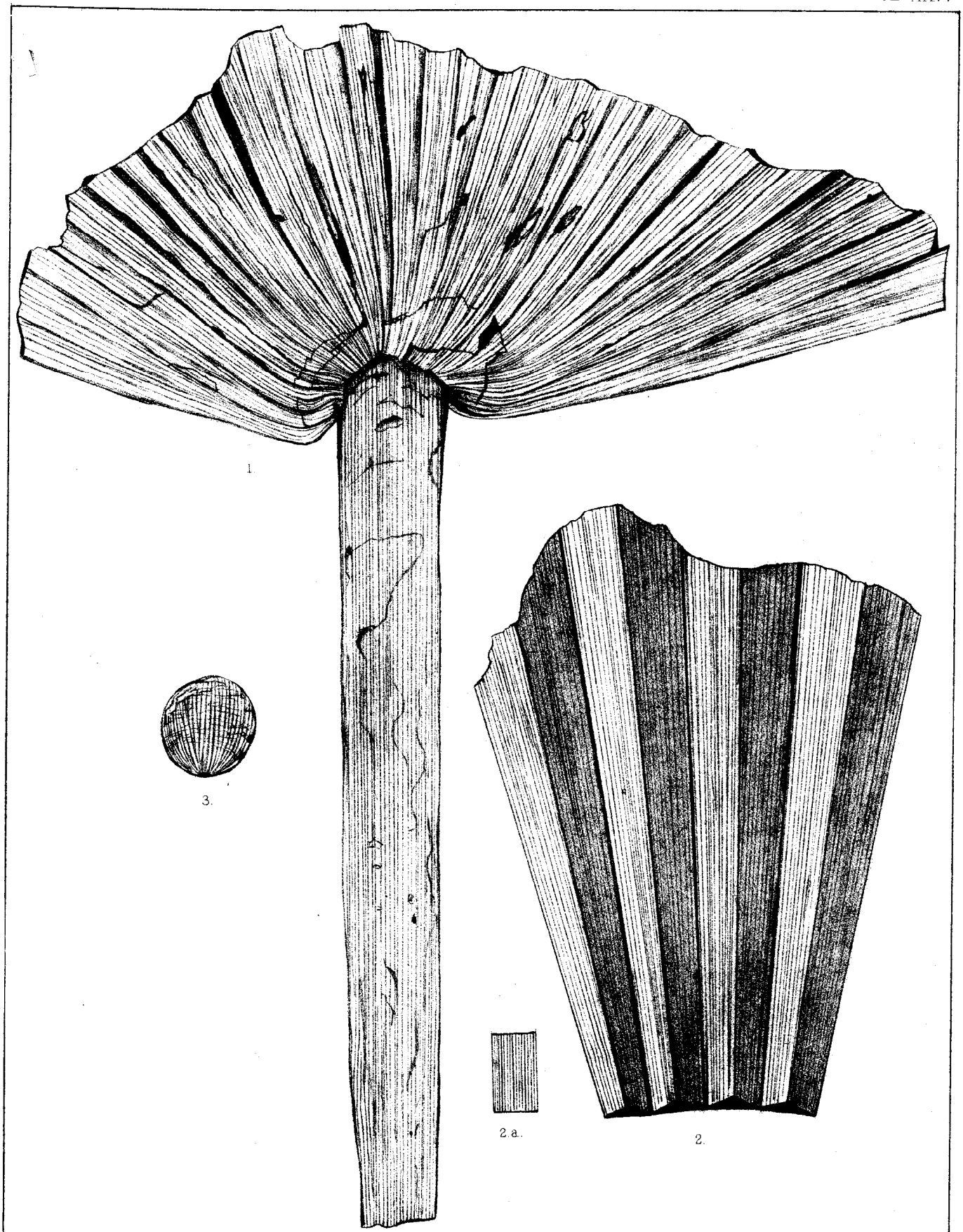
Oligocene.

PLATE XXIV.

Figures.

1–2*a*. Flabellaria Florissanti, Lesqx., p. 144.

3. Palmocarpon? globosum, Lesqx., p. 144.

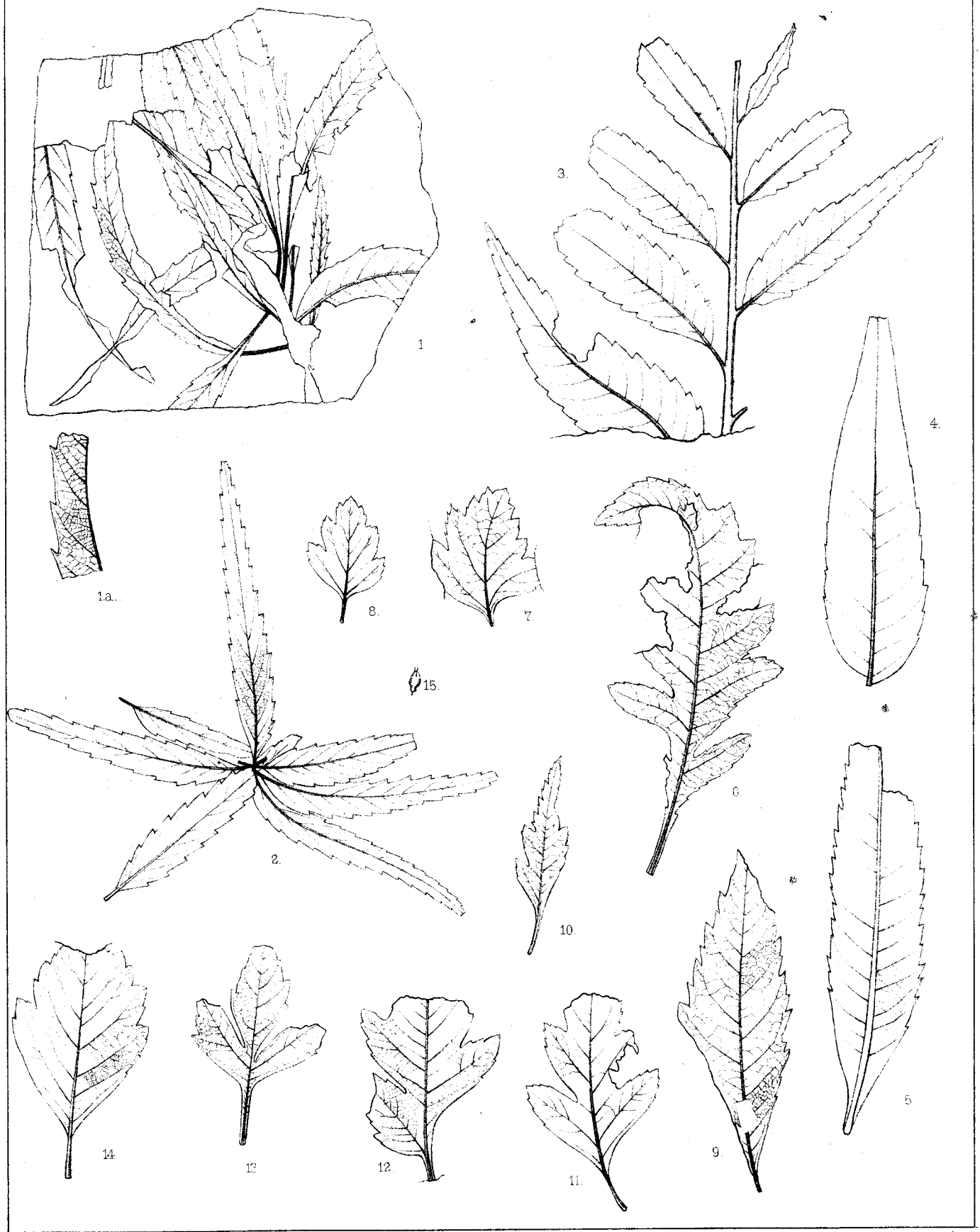

1.
3.
2.a.
2.

Oligocene.

PLATE XXV.

Figures.

1–2. Myrica polymorpha, Schp., p. 146.
3, 4. Myrica rigida, Lesqx., p. 145.
5. Myrica Zachariensis, Sap., p. 145.
6–15. Myrica diversifolia, Lesqx., p. 148.


1
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10.
11.
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14
15.

Oligocene.

PLATE XXVI.

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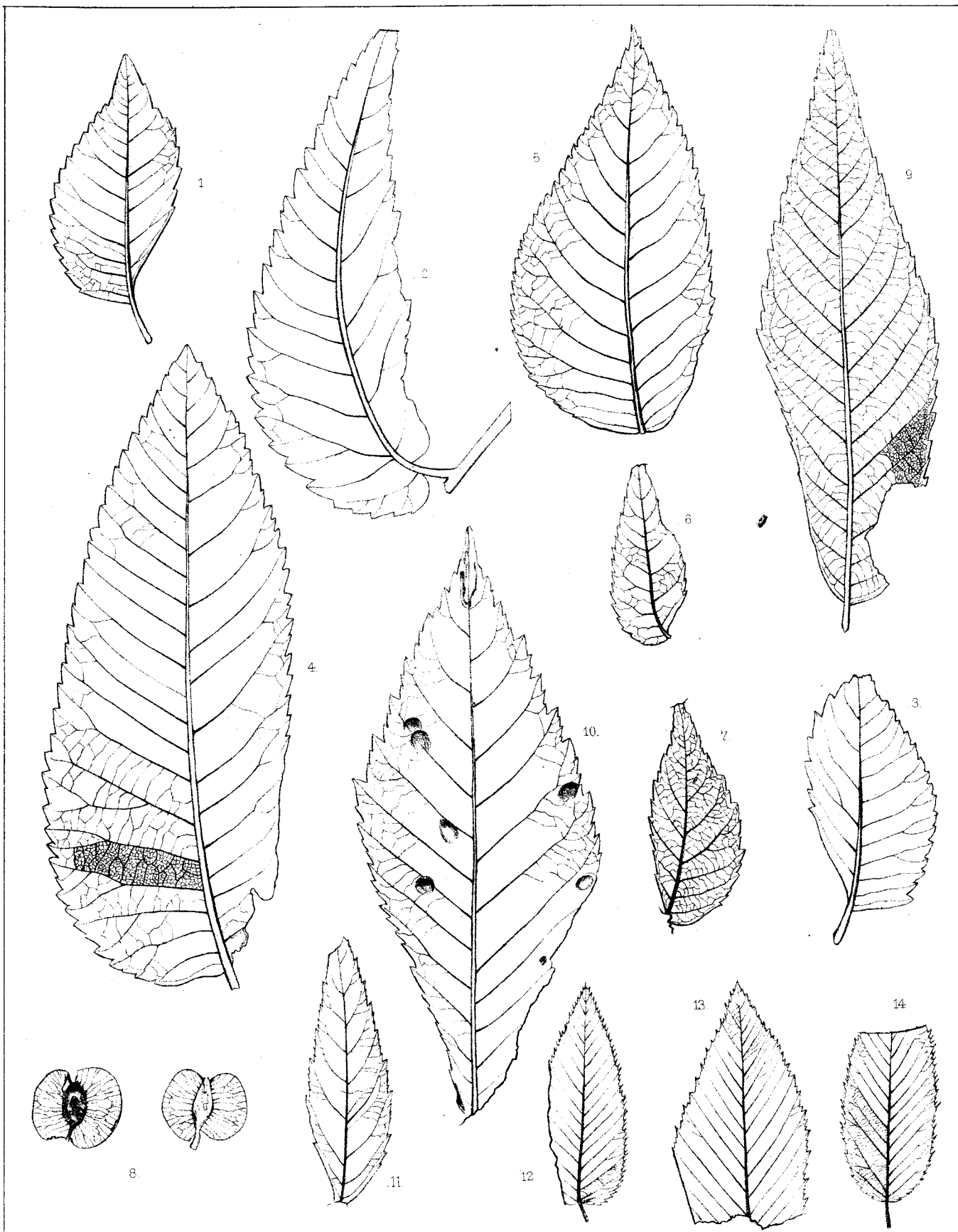
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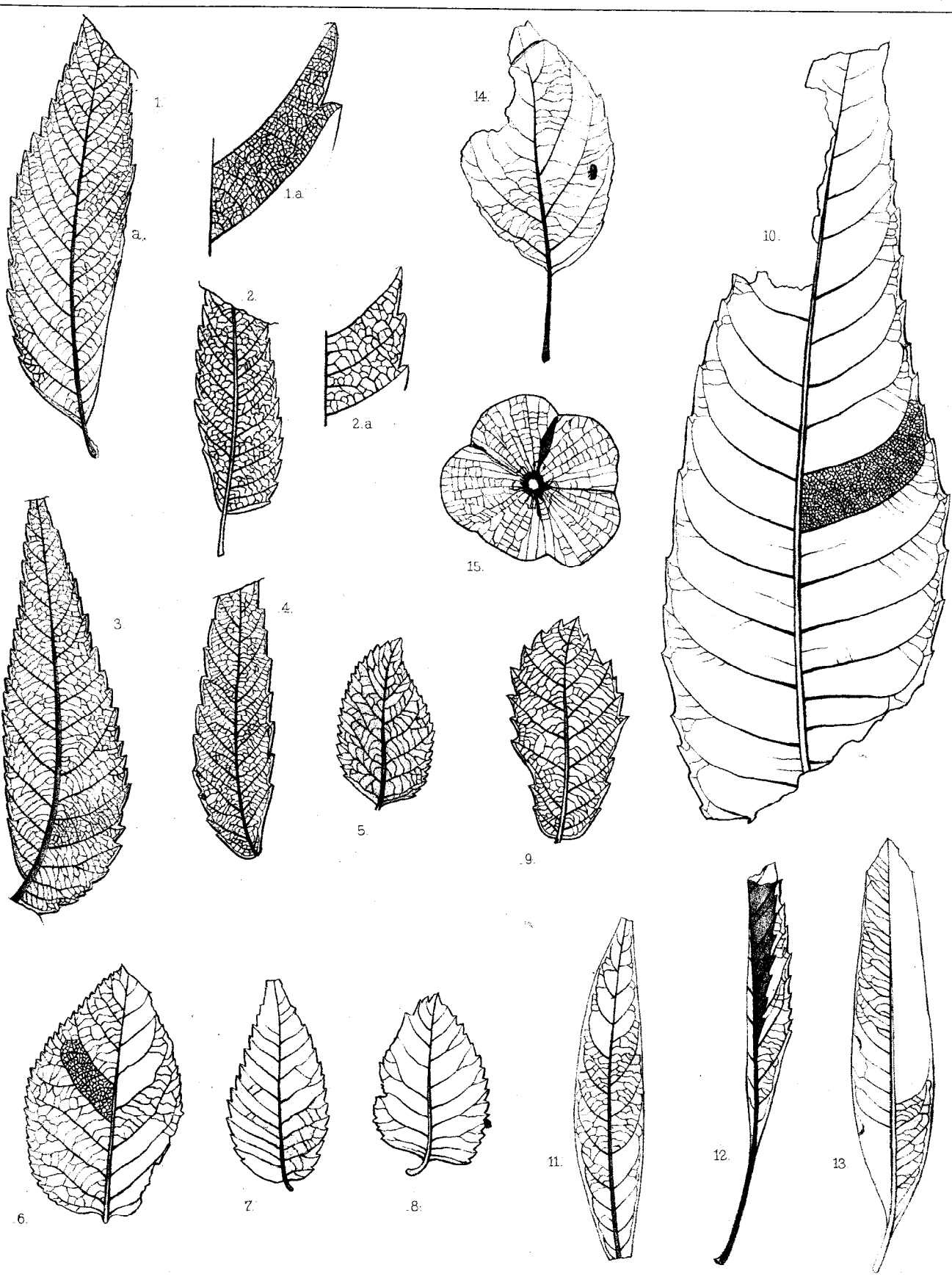
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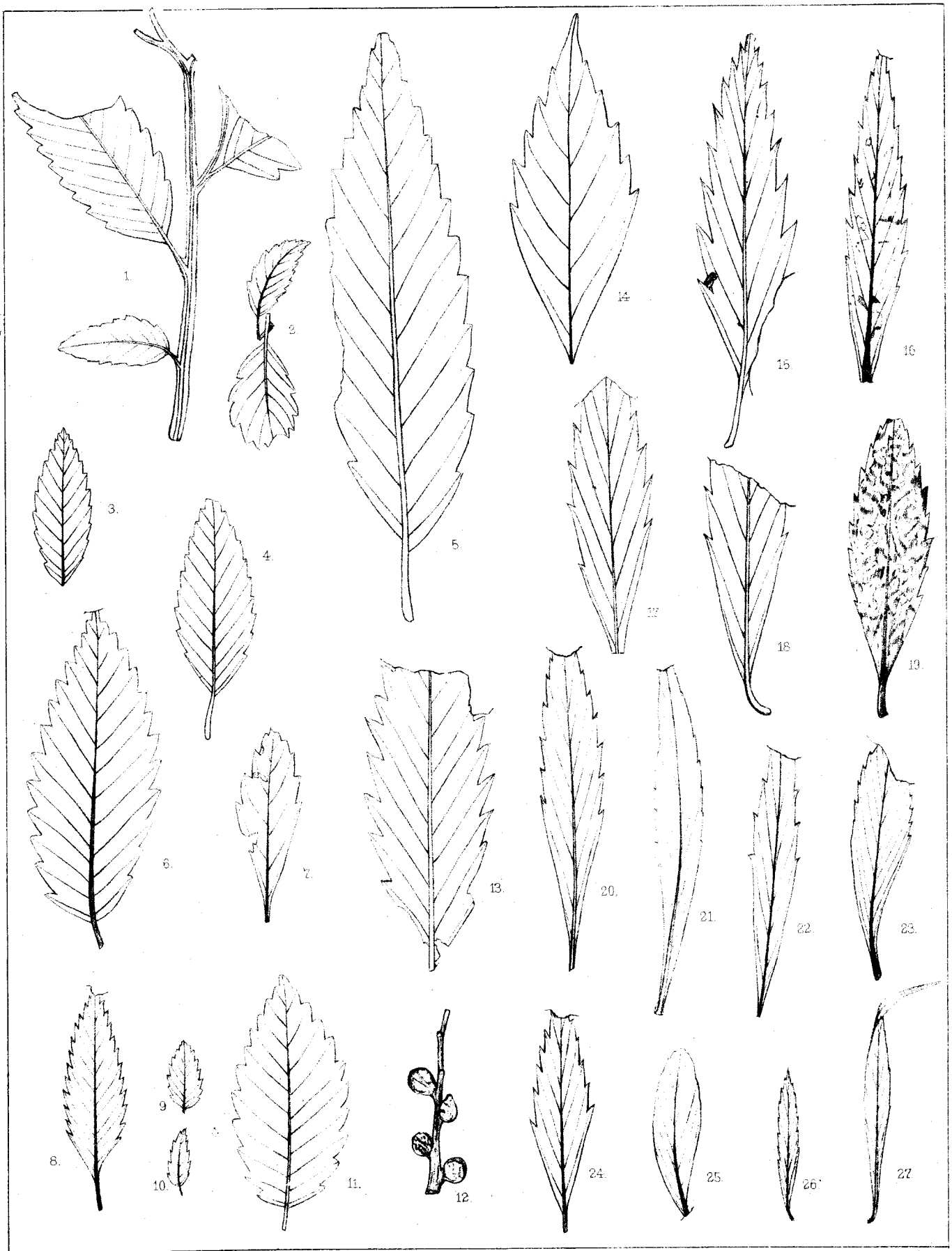

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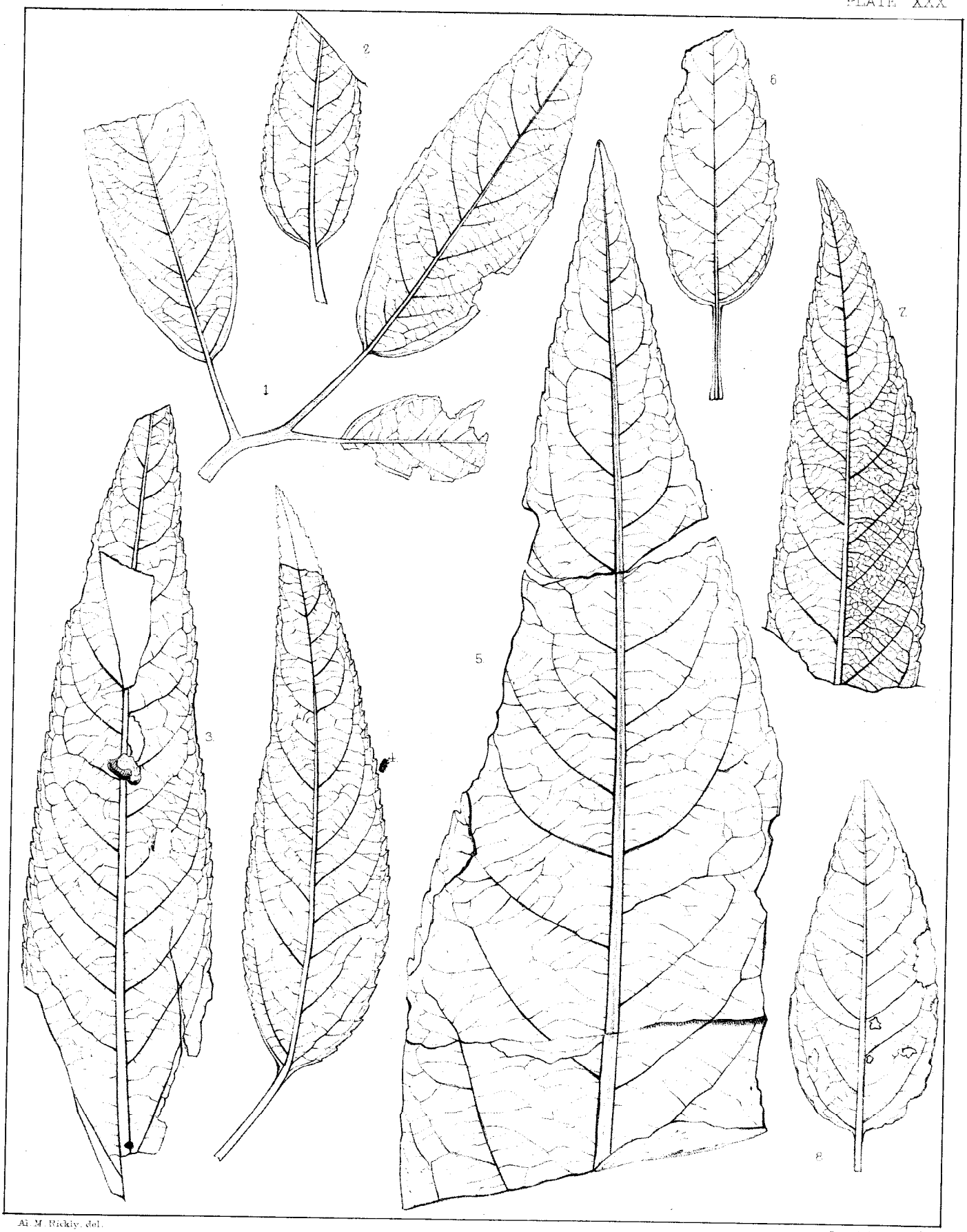
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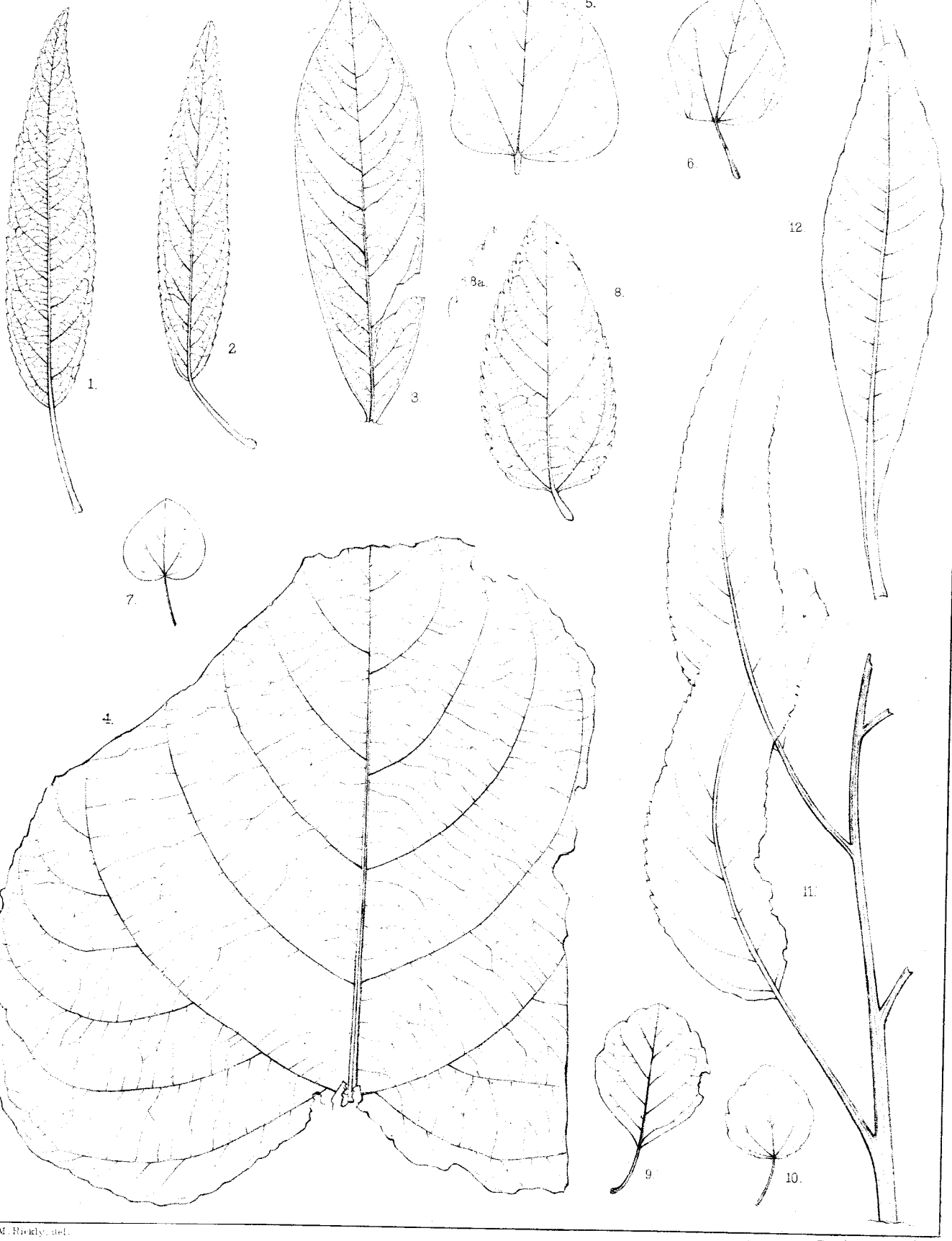

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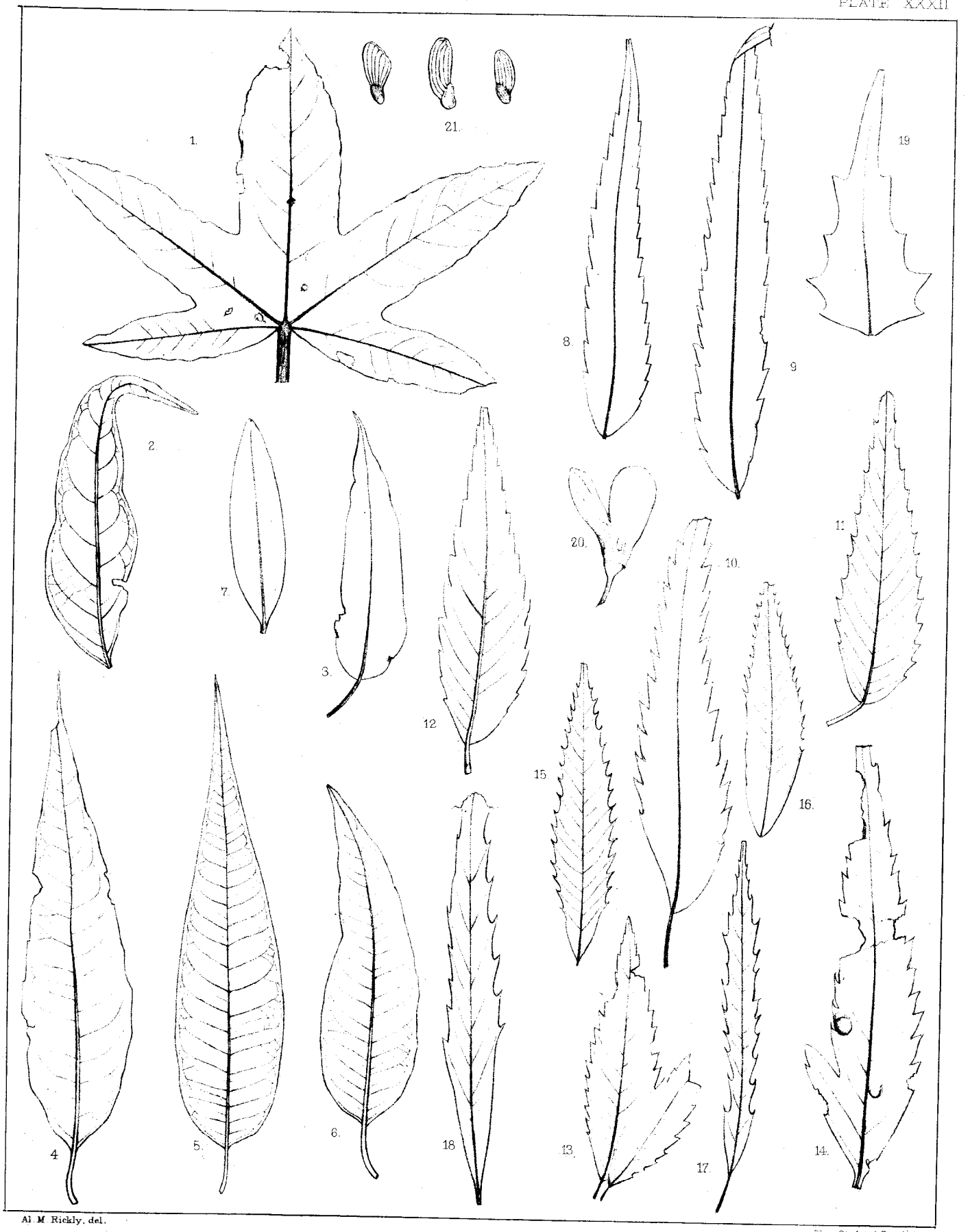

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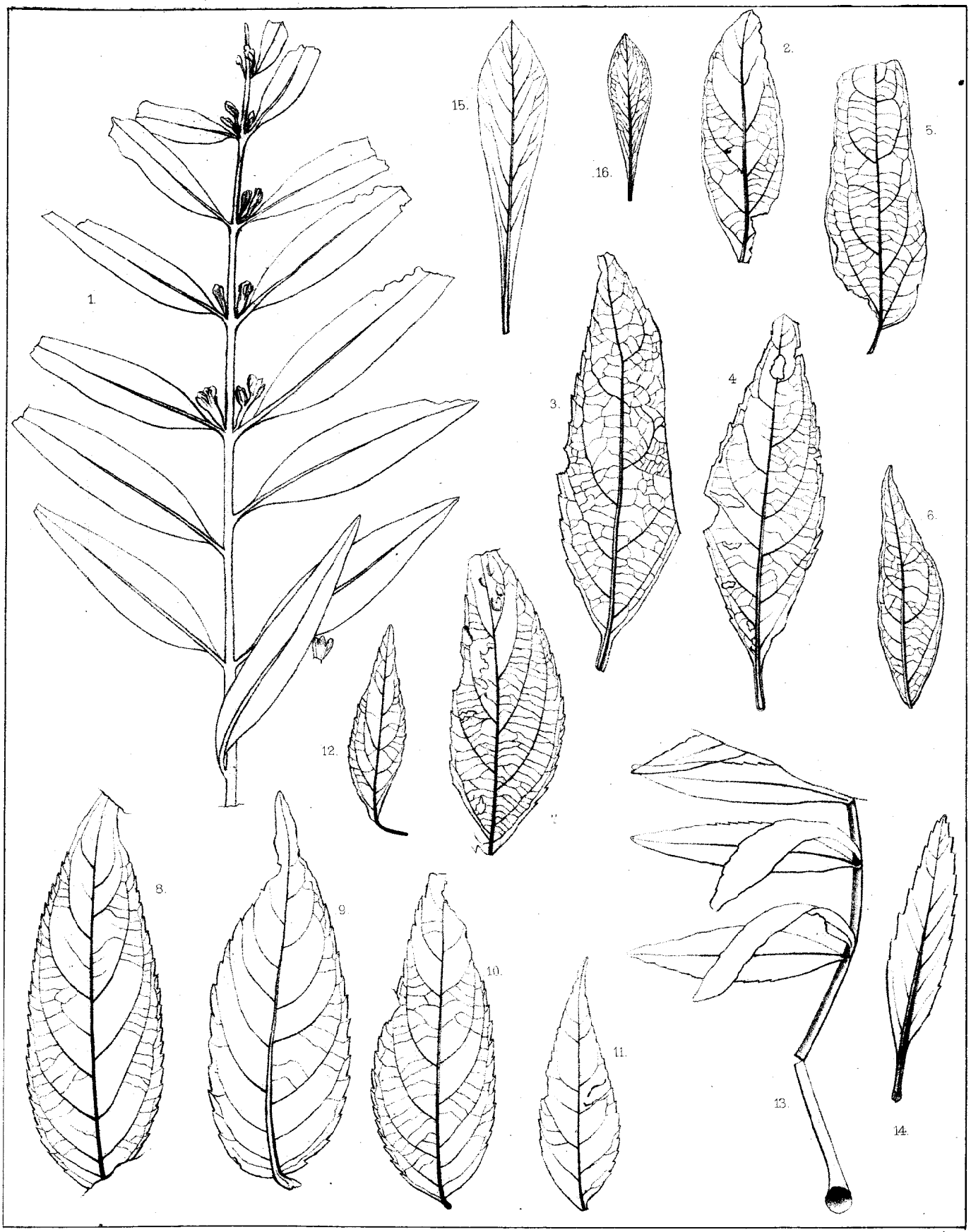
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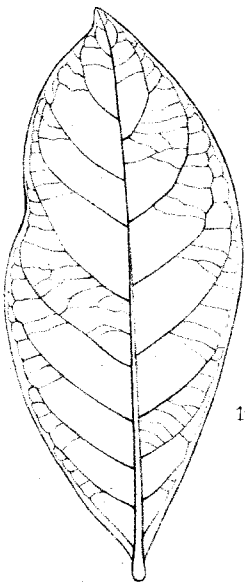

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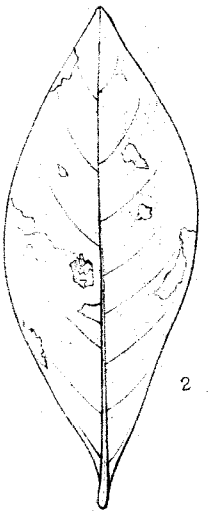

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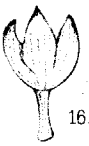

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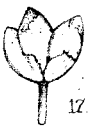

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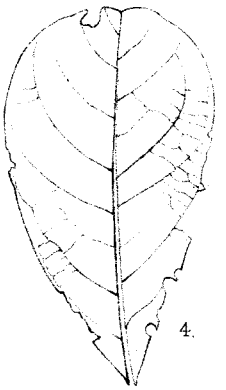

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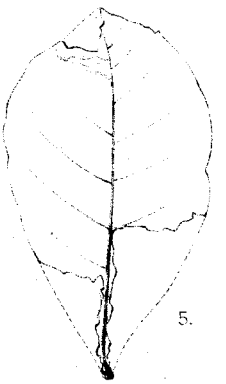

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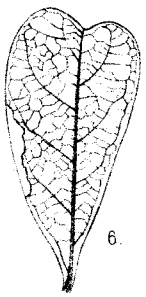

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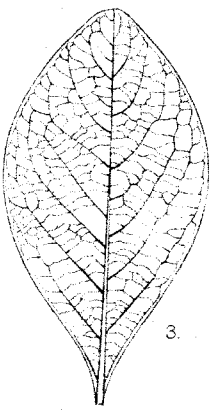

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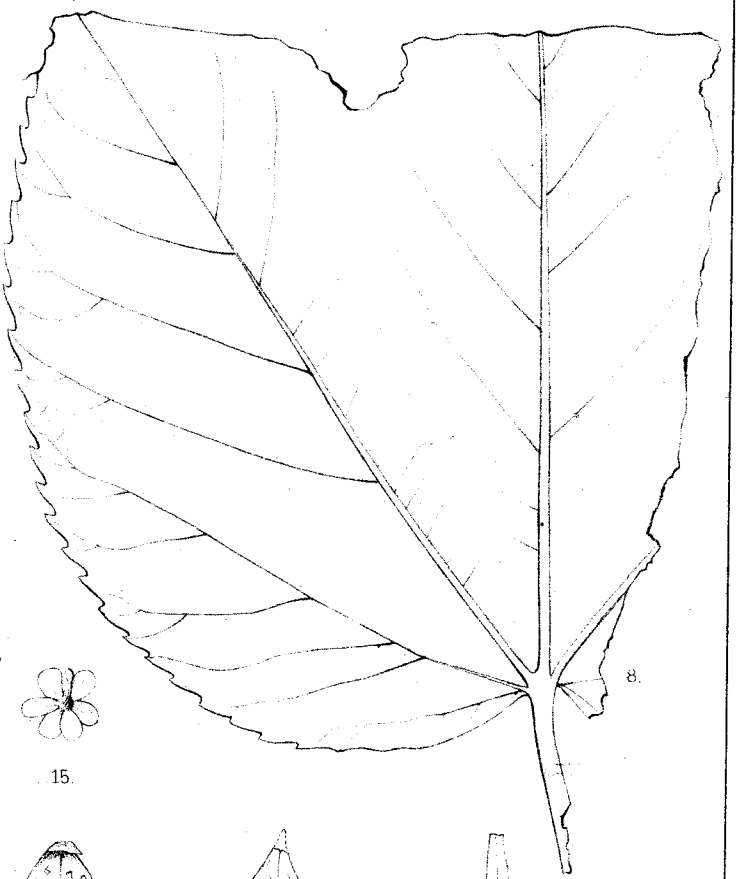

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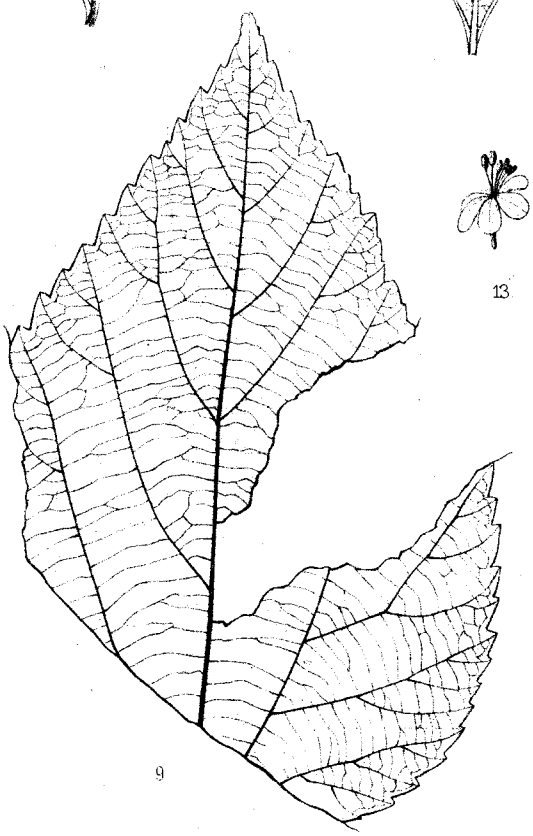

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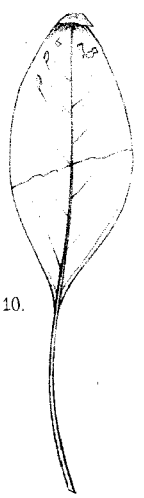

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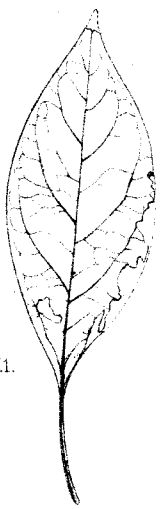

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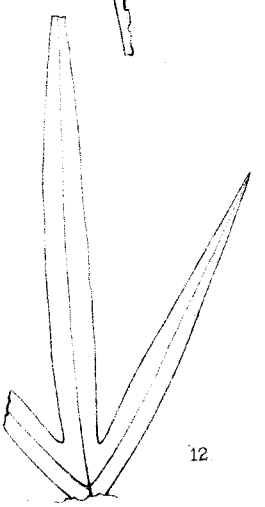

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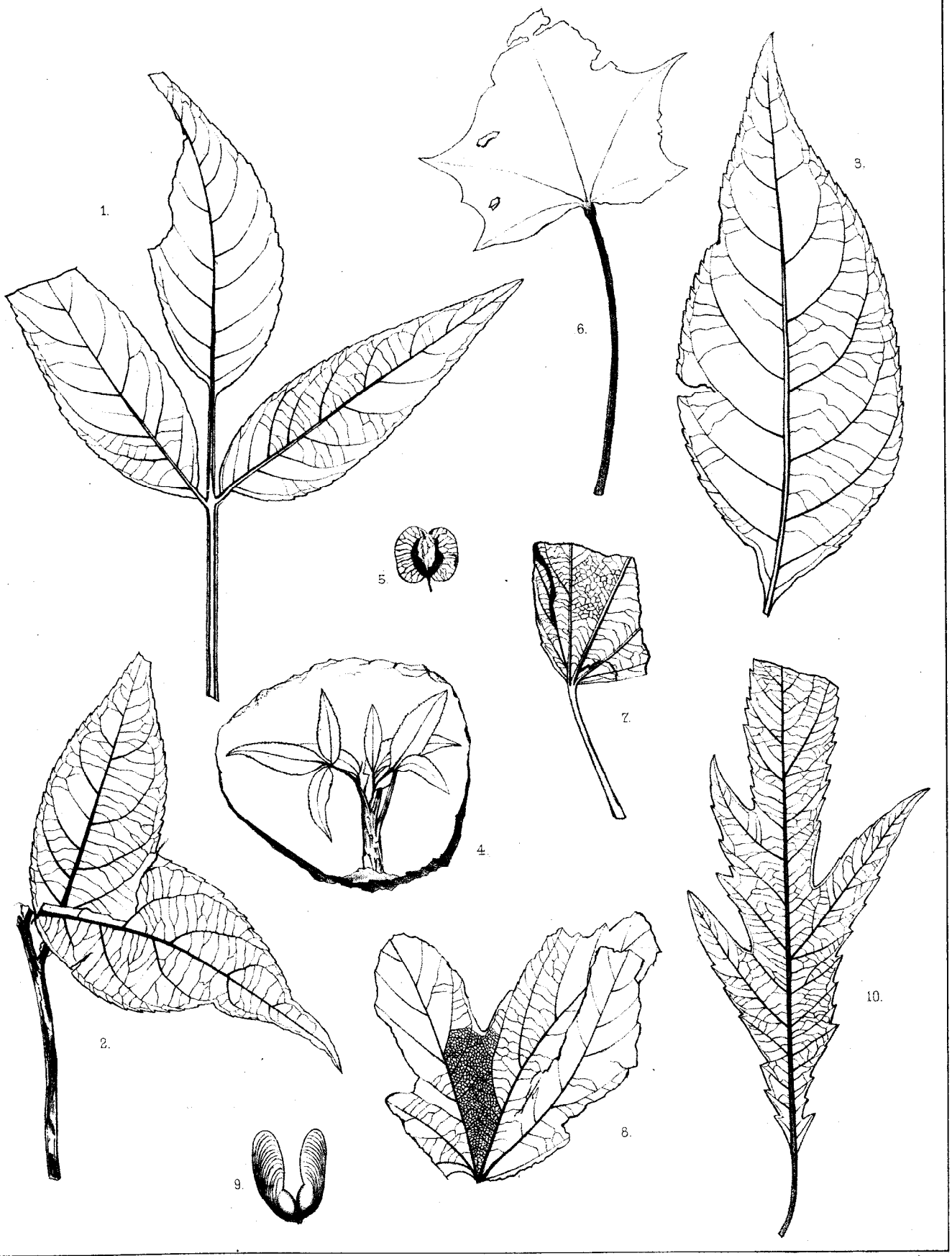
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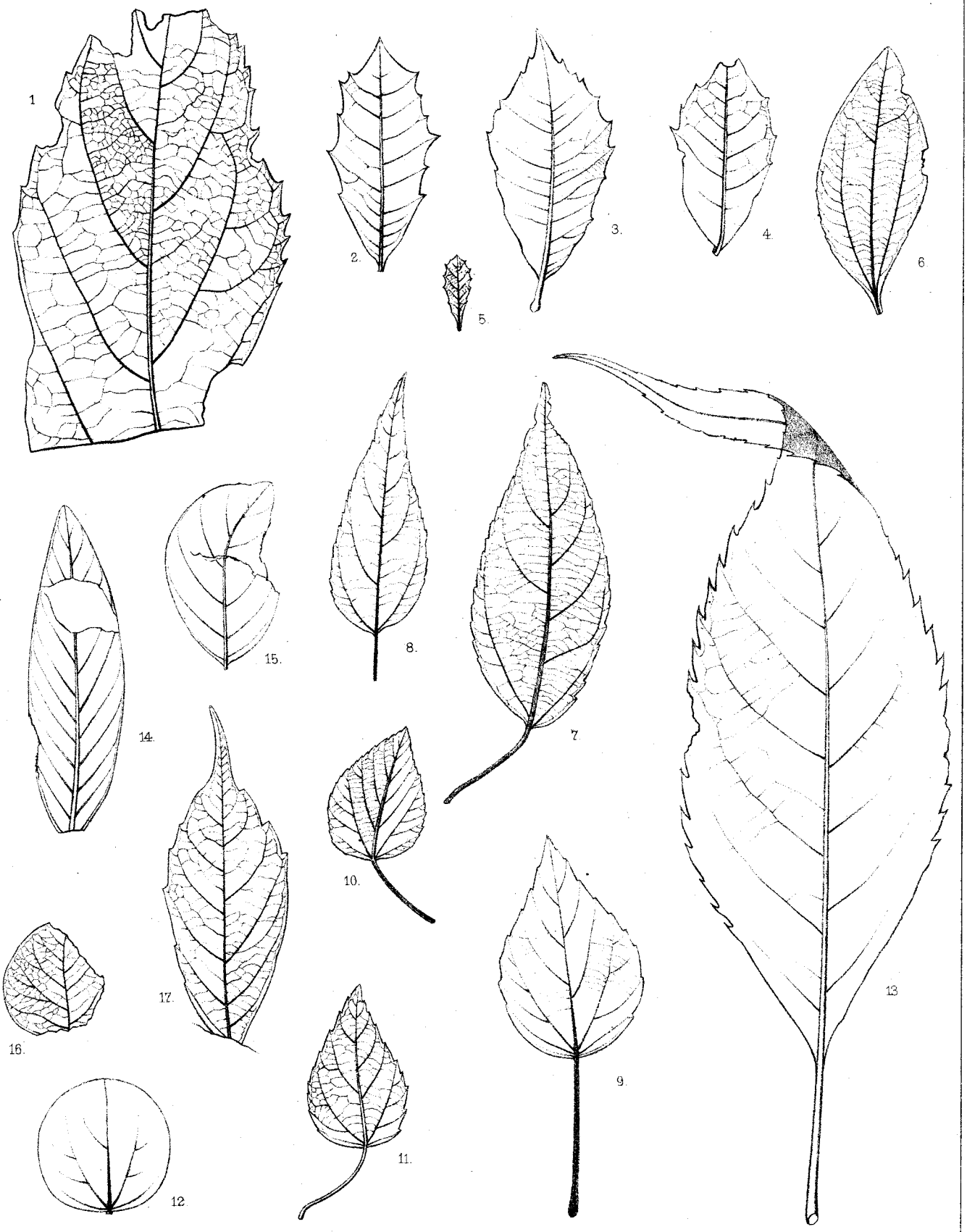
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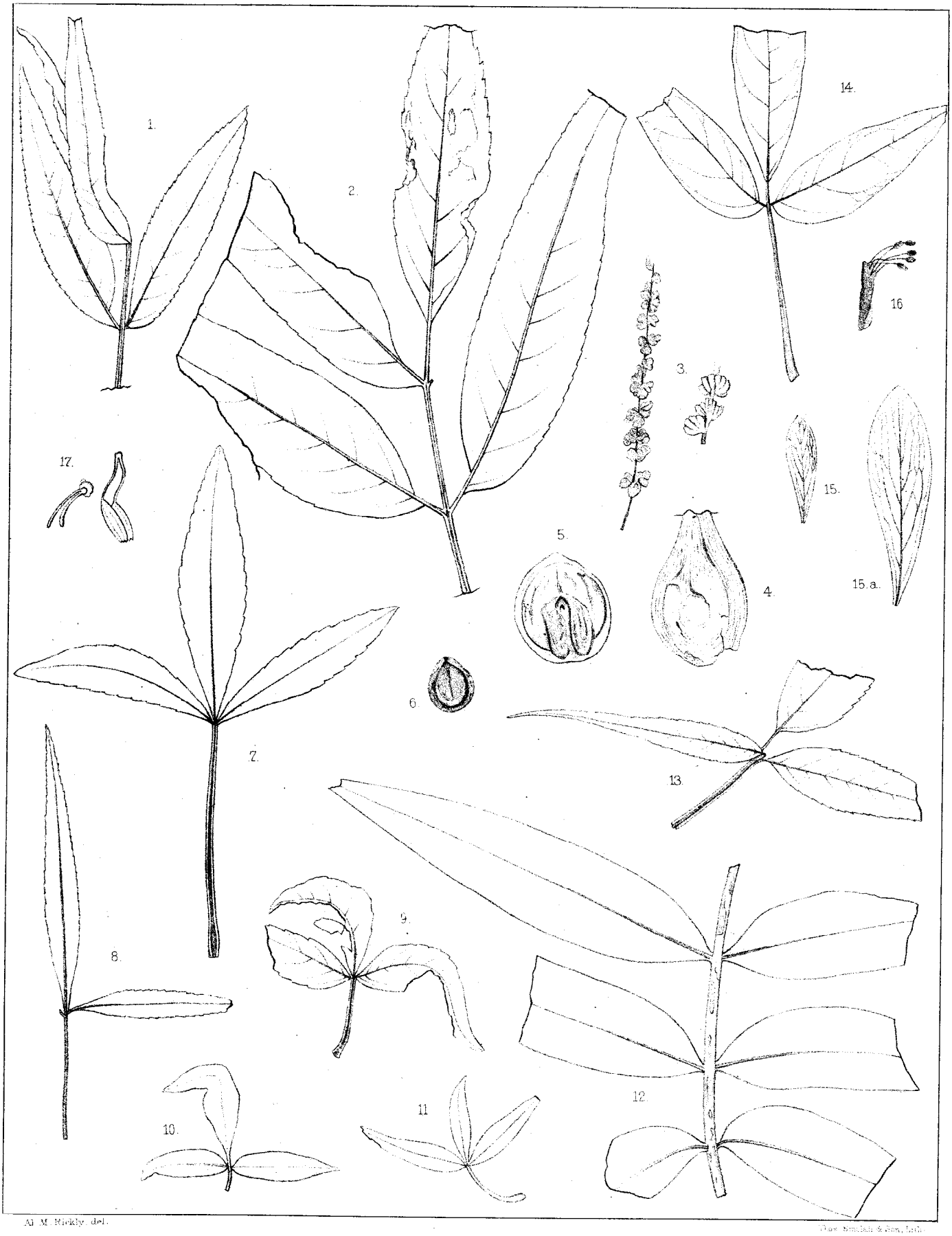
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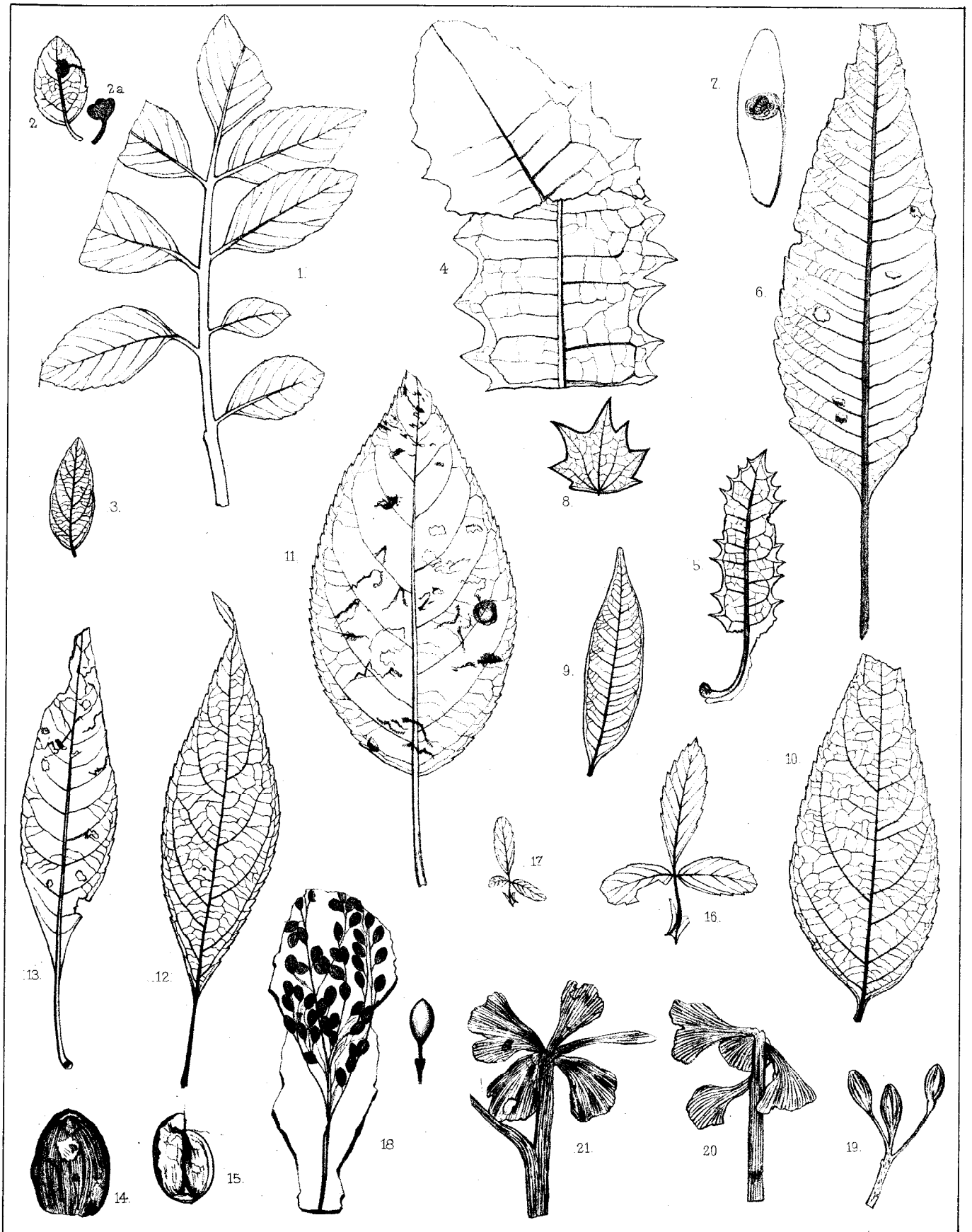
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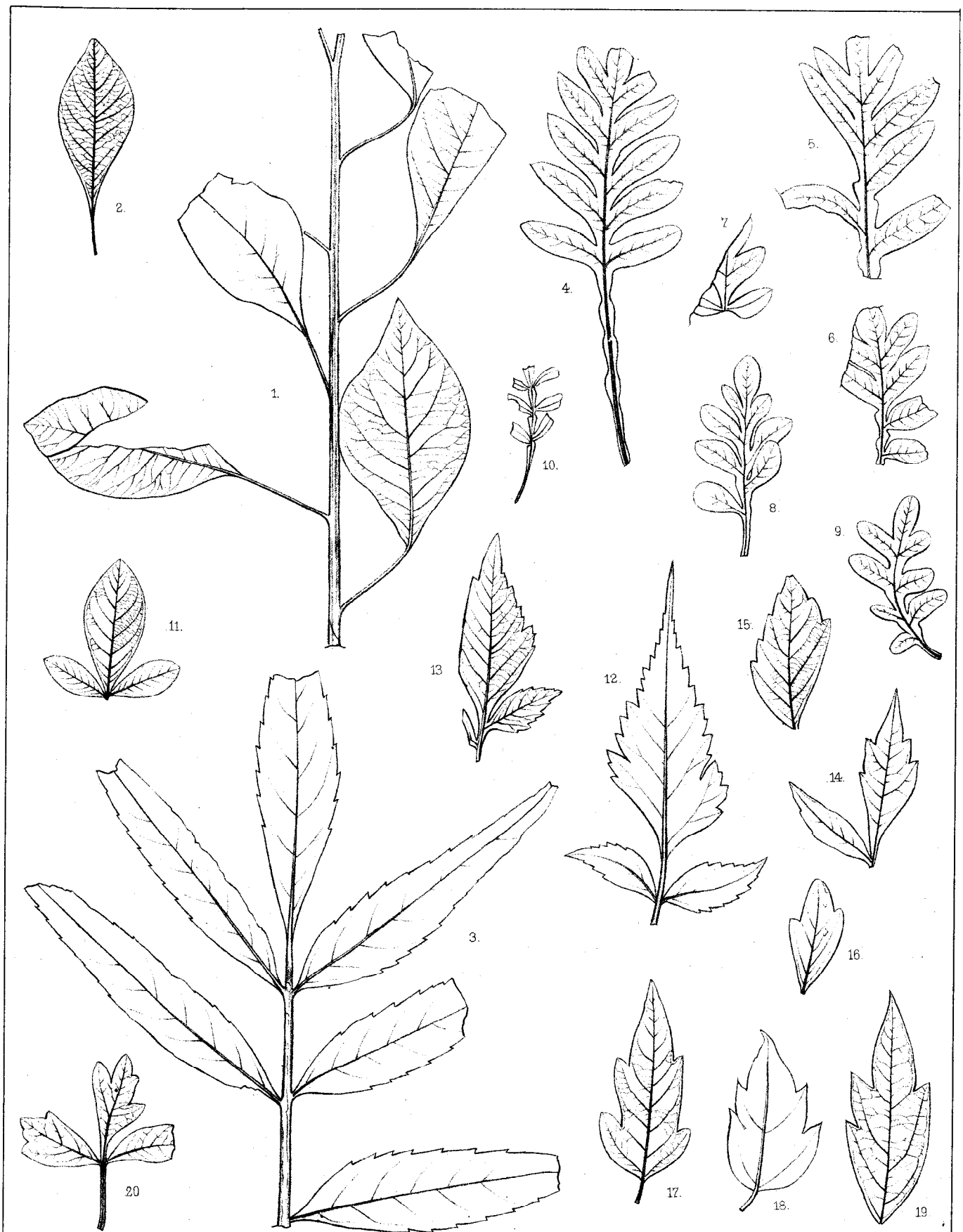

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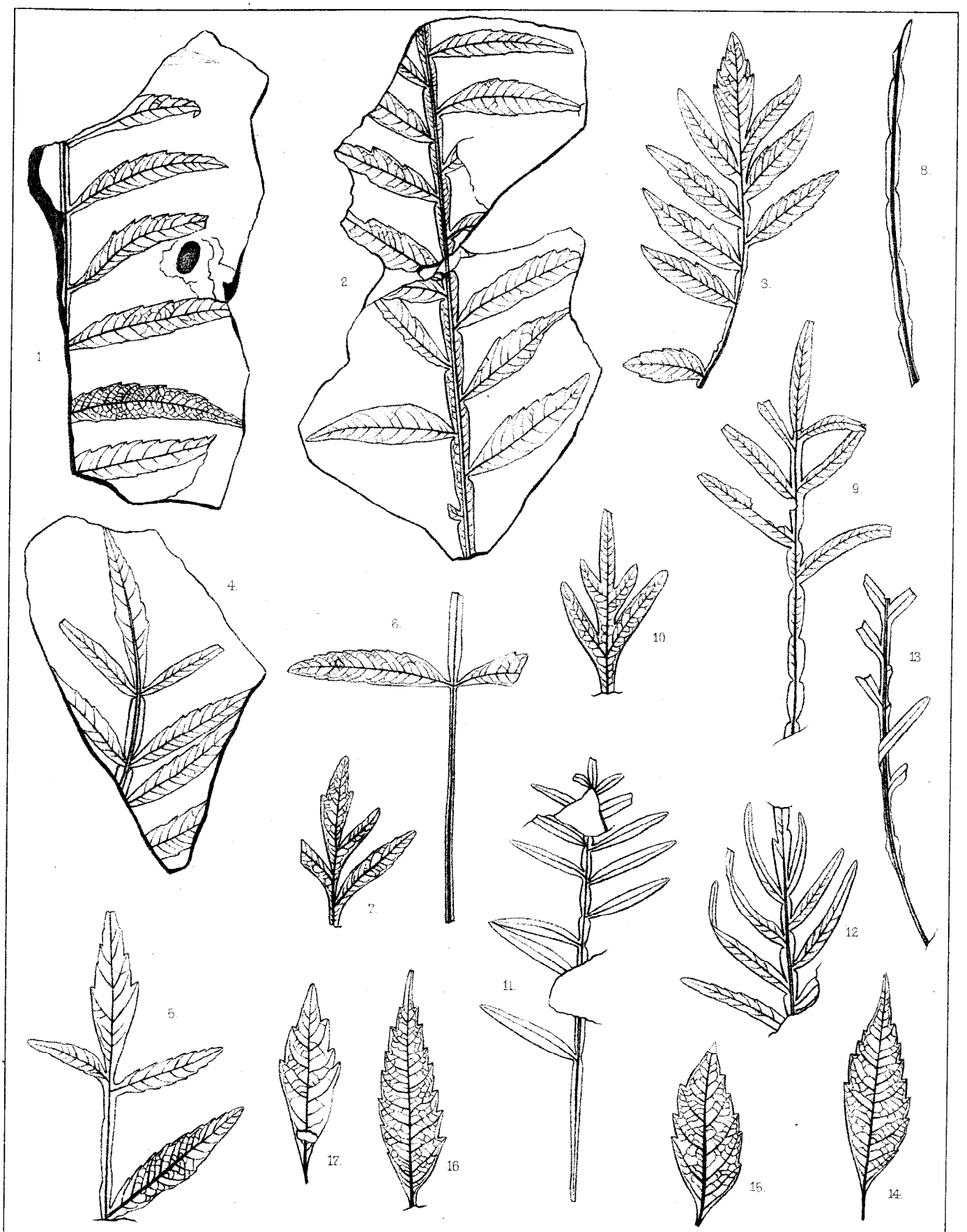
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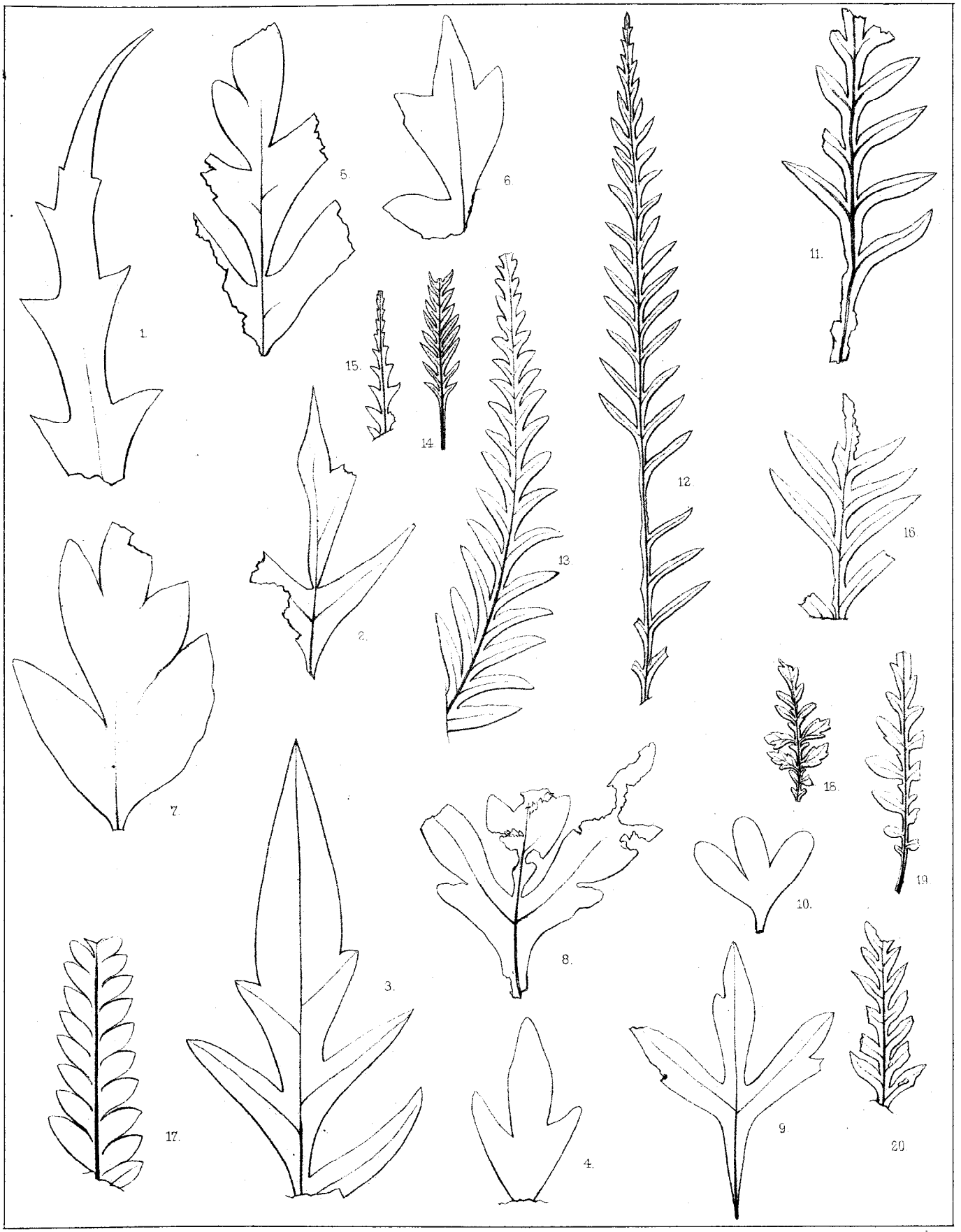
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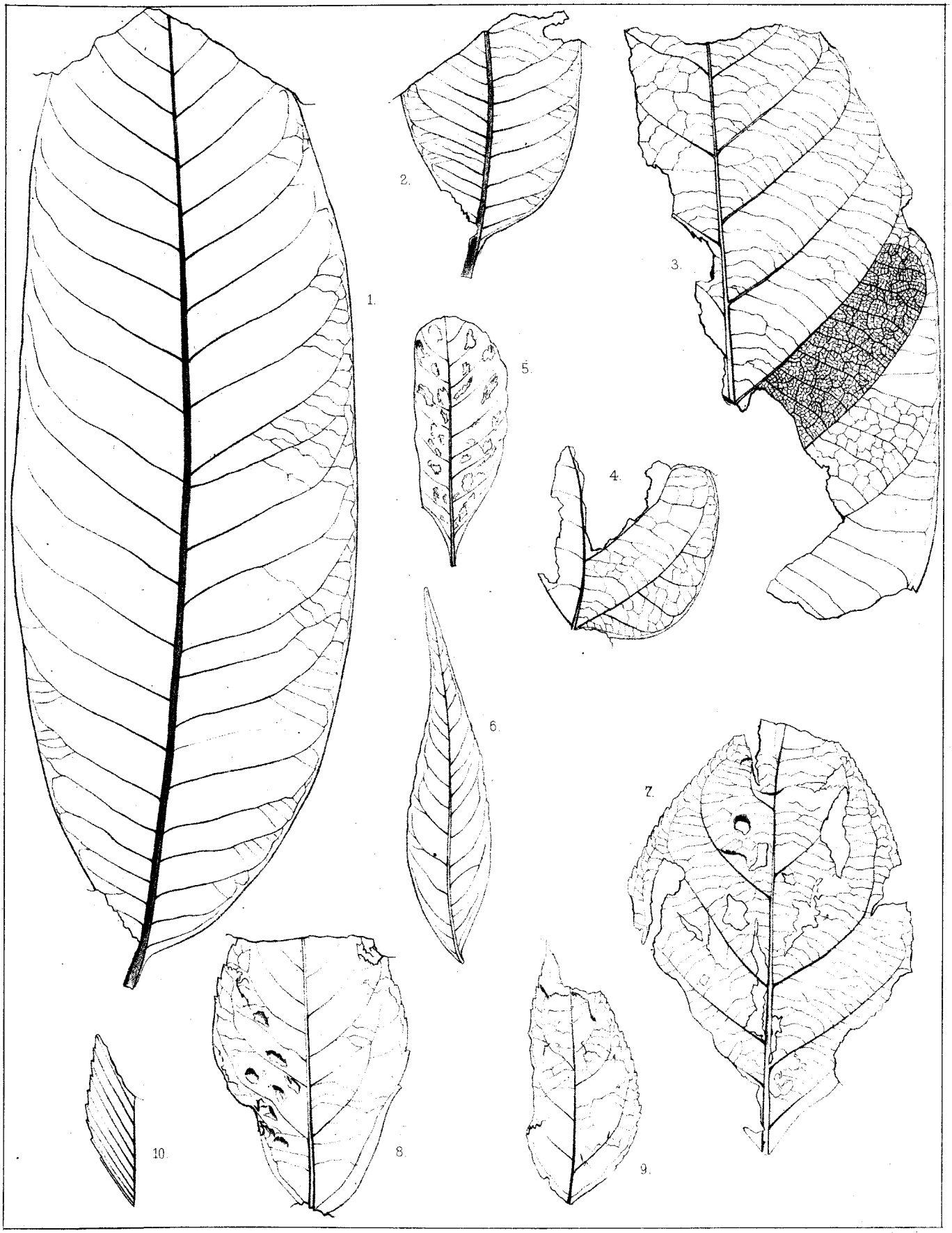
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